March 1998 www.nasatech.com Vol. 22 No. 3

TECH BRIEFS

ENGINEERING SOLUTIONS FOR DESIGN & MANUFACTURING

UPDATE SL ONLY
RETAIN PAST ISSUE

JOHN F. KENNEDY
SPACE CENTER LIBRARY
DOCUMENTS DEPARTMENT
CIRCULATION COPY

Advances in CAD/CAE

Special Coverage: Mechanical Technology

Electronics Tech Briefs

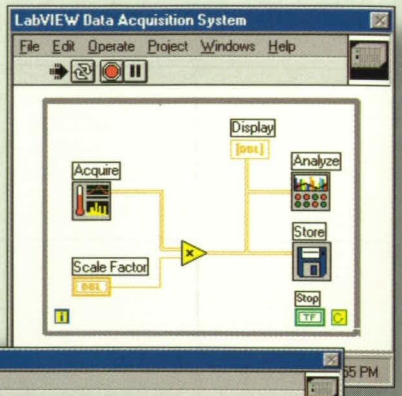
NEW! LabVIEW 5.0

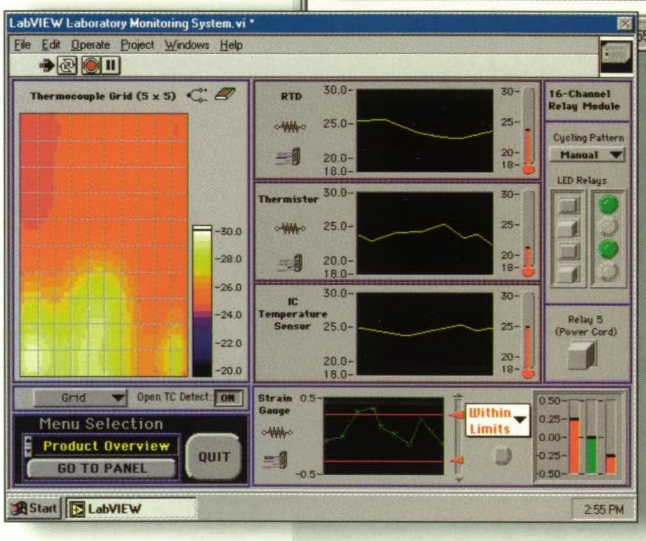
Think it.

It's just that easy – with LabVIEW. If you need to make measurements and analyze your data but don't have a lot of time, LabVIEW is just what you need.

Wire it.

Create measurement and analysis systems in a fraction of the time it takes with any other software. Virtually every industry survey has shown that the G language in LabVIEW is the most popular development tool available for data acquisition, analysis, and presentation.





Run it.

More scientists and engineers are getting results faster and easier with LabVIEW.

Call today, and turn your ideas into reality.

Call today for your FREE LabVIEW 5.0 Evaluation Version

(800) 661-6063

(U.S. and Canada)

www.natinst.com/labview

Order your upgrade on-line!

NATIONAL INSTRUMENTS™

The Software is the Instrument™

U.S. Corporate Headquarters

Tel: (512) 794-0100 • Fax: (512) 794-8411

info@natinst.com • www.natinst.com

Worldwide network of direct offices and distributors.

© Copyright 1998 National Instruments Corporation. All rights reserved.

Product and company names listed are trademarks or trade names of their respective companies.

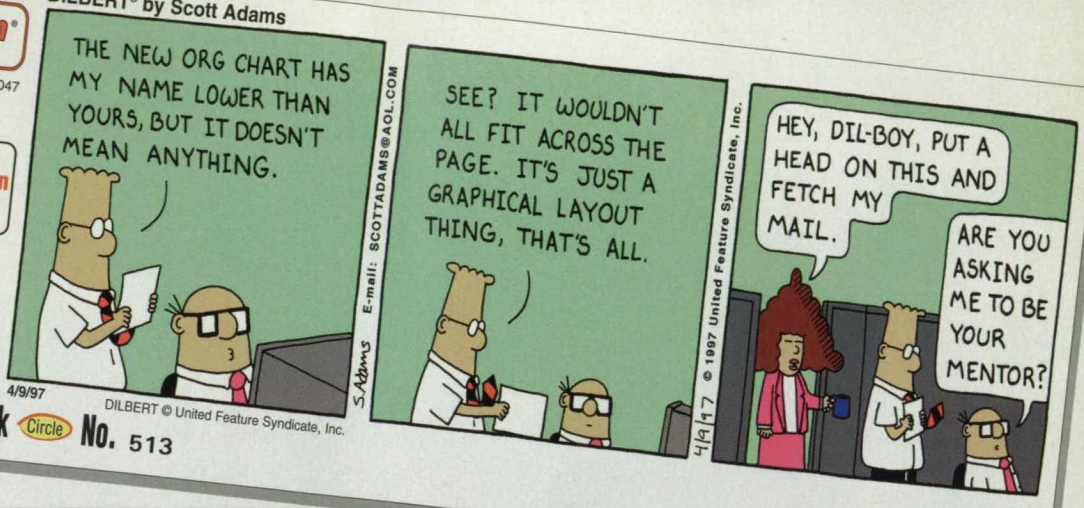
For More Information Circle No. 500

http://www.omega.com
e-mail: info@omega.com

omega.com®
ΩOMEGA®
One Omega Drive, P.O. Box 4047
Stamford, CT 06907-0047

To Request Your DILBERT® Deck Card Pack, Dial: 1-(203)-329-1266

DILBERT® by Scott Adams



Get Your Dilbert Card Deck Circle No. 513

Where Do I Find Dataloggers?
OMEGA...Of Course!

Low Cost Temperature and Humidity Datalogger
Model OM-NOMAD
$135 Basic Unit
Document #6358 OMEGAfax

Low Cost Versatile Datalogger

Model OM-180 Series
$640 Basic Unit
Document #6404 OMEGAfax

Expandable Datalogging System

Model OM-320 $3000 Basic Unit
Document #6395 OMEGAfax

For more information, call OMEGAfax℠ on-line publishing service at 1-800-848-4271 and request desired document numbers.

Low Cost Handheld Datalogger

Model AD128
$799
Document #6365 OMEGAfax

For Sales and Service, Call:
1-800-82-66342℠
1-800-TC-OMEGA

omega.com™
ΩOMEGA®

© COPYRIGHT 1997 OMEGA ENGINEERING, INC. ALL RIGHTS RESERVED
Patent Applied For

Where Do I Find Plug-In Boards?
OMEGA...Of Course!

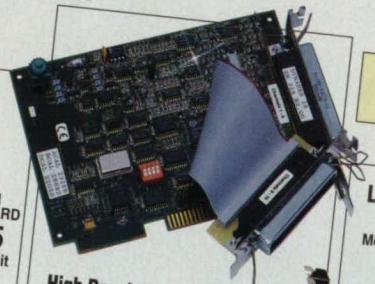
See Dilbert® On The Reverse Side Of This Card!

http://www.omega.com

DAQBOARD Expandable Board

Model DAQBOARD
$795 Basic Unit
Document #6323 OMEGAfax

omega.com™
ΩOMEGA®



High Resolution Board
Model WB-DYNARES
$595 Basic Unit
Document #6412 OMEGAfax

For more information, call OMEGAfax℠ on-line publishing service at 1-800-848-4271 and request desired document numbers.

Low Cost Boards
Model DAQ-800 Series
$295
Document #6376 OMEGAfax

High Speed Boards
DAQ-1100 Series
$575
Document #6377 OMEGAfax

For Sales and Service, Call:
1-800-82-66342℠
1-800-TC-OMEGA

e-mail: info@omega.com

©COPYRIGHT 1997 OMEGA ENGINEERING, INC. ALL RIGHTS RESERVED
Patent Applied For

NEW! FREE!

Vol. MM™
21st Century™ Preview Edition

NEW! FREE!

YOUR SOURCE FOR

Temperature
Flow & Level
Pressure, Strain & Force
Data Acquisition
pH & Conductivity
Electric Heaters
Environmental

Request The Vol. MM™ 21st Century™ Preview Edition Circle No. 514 or Dial 1-800-848-4271 for OMEGAfax℠ Service and Request Document #9983

e-mail: info@omega.com
http://www.omega.com/track/sp-ntb/398

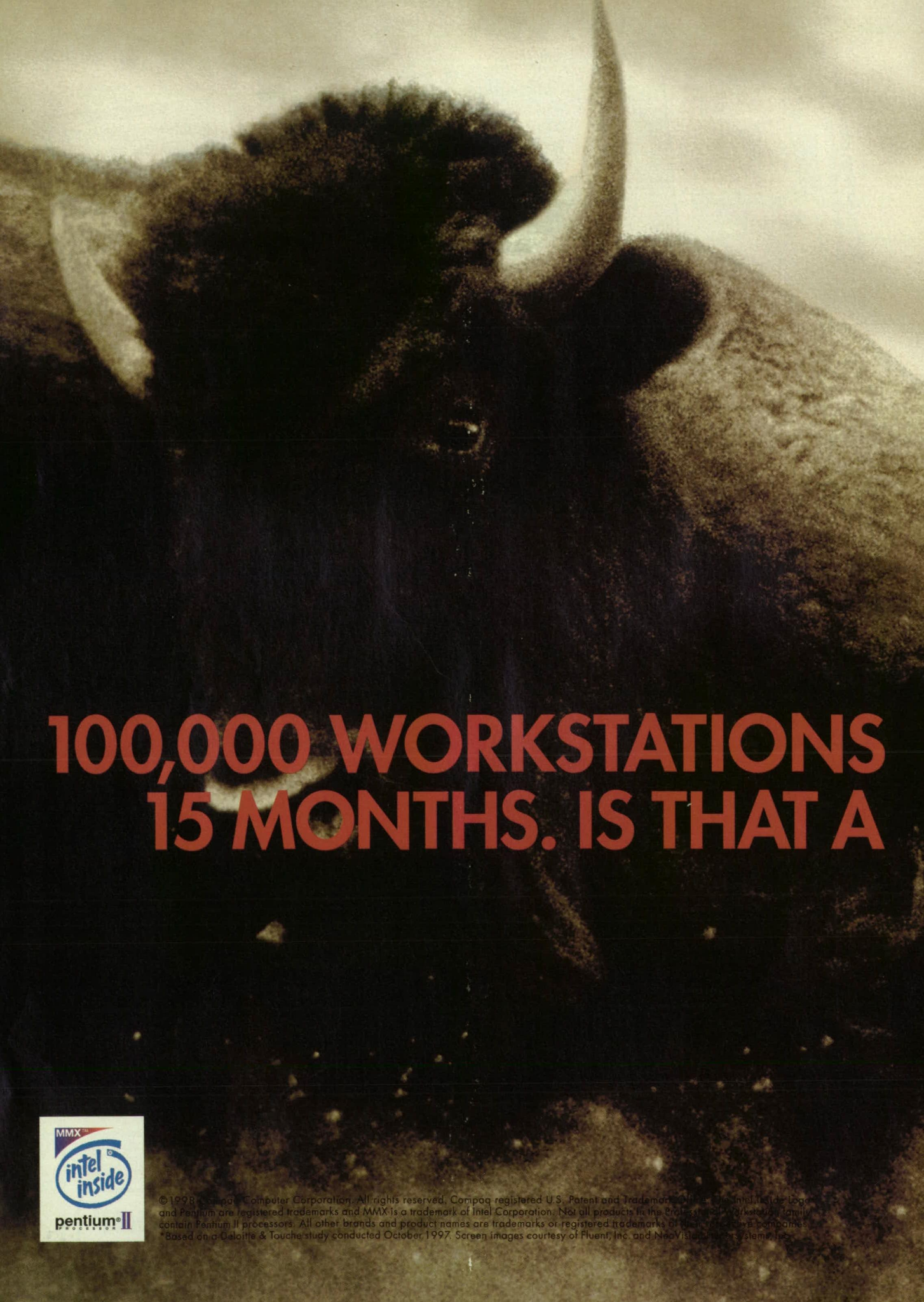
OMEGAfax℠
OMEGA's 24-Hour-a-Day, On-Demand Publishing Service
DIAL 1-800-848-4271

For Sales and Service Call: 1-800-82-66342℠ 1-800-TC-OMEGA

ISO 9001 CERTIFIED CORPORATE QUALITY

omega.com®
ΩOMEGA®

OMEGA ENGINEERING, INC., ONE OMEGA DRIVE, P.O. BOX 4047, STAMFORD, CT. 06907-0047
©COPYRIGHT 1998 OMEGA ENGINEERING, INC. ALL RIGHTS RESERVED.



©1998 Compaq Computer Corporation. All rights reserved. Compaq registered U.S. Patent and Trademark Office. Intel, Intel Inside Logo and Pentium are registered trademarks and MMX is a trademark of Intel Corporation. Not all products in the Professional Workstation family contain Pentium II processors. All other brands and product names are trademarks or registered trademarks of their respective companies.
*Based on a Deloitte & Touche study conducted October 1997. Screen images courtesy of Fluent, Inc. and NeoVision Hypersystems Inc.

Whatever you decide to call it, the shift from proprietary UNIX workstations to industry-standard Compaq Professional Workstations has been remarkable. Only 15 months after entering the market, we shipped our 100,000th workstation. A feat that took Silicon Graphics eight years to accomplish and Sun Microsystems six years. Our full range of Compaq Professional Workstations is optimized to run the most demanding business, technical and creative applications thanks to our innovative Highly Parallel System Architecture. This industry-standard architecture delivers 1.07GB/s of application memory bandwidth, giving performance you never thought possible from a Windows NT® system. So you can run your demanding applications without compromise. Leading-edge applications like Pro/ENGINEER, I-DEAS™ Master Series, Unigraphics, MicroStation, SolidWorks and AutoCAD, plus all of your day-to-day business applications, eliminating the need for a second machine. All at a lower total cost of ownership than traditional UNIX workstations*. Would you expect less from the world's leading provider of computers? Visit us at www.compaq.com/products/workstations.

COMPAQ

For More Information Circle No. 516

SOLD IN THE FIRST TREND OR A STAMPEDE?

Style and Purpose

Industrial Flat-Panel Monitors and Intelligent Displays

Dolch Display Systems embody years of experience developing flat-panel monitors, digital video interfaces and rugged, environmentally sealed caseworks. Designed for space-constricted environments, Dolch displays are extremely thin and require minimal clearance – and, no cooling air. Completely sealed all-metal construction throughout guarantees long-term ruggedness and offers environmental protection levels of NEMA 12 or 4 (IP 66) and NEMA 4X with a 304 stainless case. Select from any of 59 different configurations or specify your own custom configuration, all with Dolch's worldwide support and service.

- **Display Sizes** from 10.4" to 16.1" active area, all available with touchscreen interfaces.
- **Screen Resolutions** from 640x480 VGA to 800x600 SVGA, 1024x768 XGA and 1280x1024 SXGA.
- **Three Mounting Styles:** stand-alone DataView™, bulk-head designed PanelMount™, custom mount OmniView™.
- **Pentium® Embedded Computers** enhance Smart Series™ models with local intelligence and network access.
- **Analog or Digital Fiber-Optic** interfaces solve any interconnection challenge.

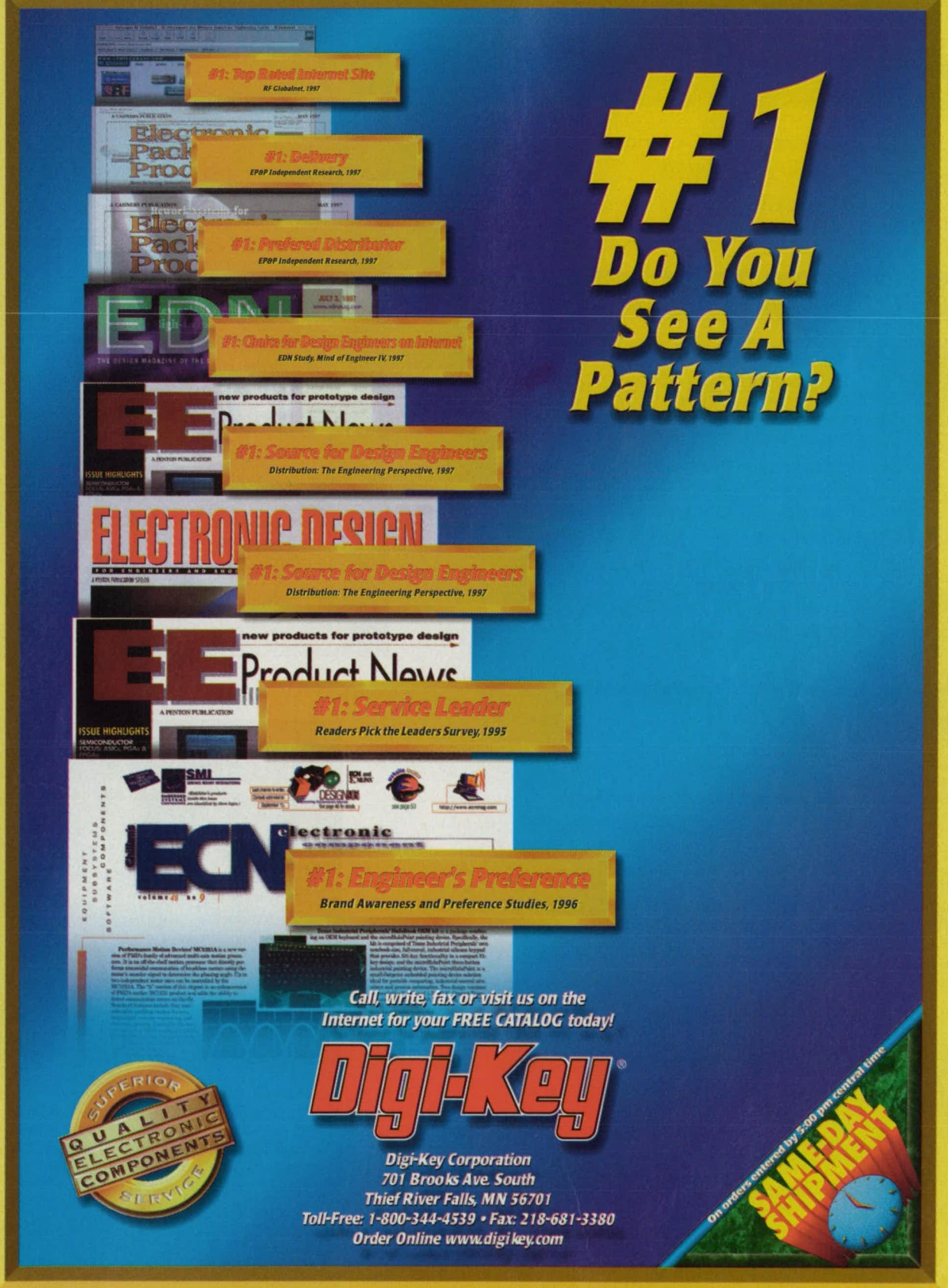
Dolch.

800.995.7581 — www.dolch.com

Dolch Computer Systems, Inc. • 3178 Laurelview Court Fremont, Ca 94538 • Tel: 510 661 2220 • Fax 510.490.2360

See us at the National Industrial Automation Show, Booth #4663

For More Information Circle No. 518



For More Information Circle No. 533

NASA TECH BRIEFS

March 1998 • Vol. 22 No. 3

Features

22 40 Years of NASA Innovations: CAD/CAM Software

30 Application Briefs

Briefs

34 Special Coverage: Computer-Aided Design & Engineering

34 Software for Assessing Effects of Designs on Operations

34 Program for Design Analysis of Cache Memory

36 Program for Microanalysis of Composite Structures

36 Genetic Algorithms Help Design Dielectric Grating Filters

40 Software for Tooth-Contact Analysis of Spiral Bevel Gears

46 Electronic Components and Circuits

46 Rechargeable Microbatteries With Li Anodes Formed In Situ

48 Lightweight Dual-Beam Reflector Antenna

52 Electronic Systems

52 Automated Cable-Analyzer System — ACAS

52 Optical Horizontal-Displacement Sensors for Crane Payloads

56 Sight-to-Touch Translator

58 Physical Sciences

58 Automated Dew-Point/Frost-Point Humidity Generator

58 Improving Distributions of Flux in Solar Thermal Receivers

60 Equations of State for Fluid Mixtures at High Pressures

63 Convex-Grating Spectrometer With Two Spherical Mirrors

64 Weighted-Hyperbola Technique for Locating Pulsed Sources

65 Silicon Heat Exchanger for Use at Low Temperatures

Departments

14 Commercial Technology Team

16 UpFront

18 Reader Forum

32 Commercialization Opportunities

42 Special Coverage Products: Computer-Aided Design & Engineering

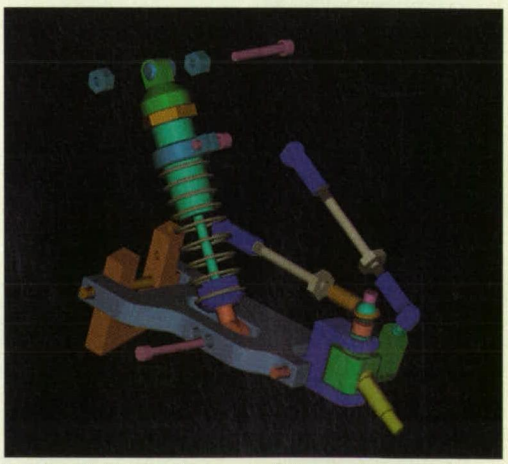
80 Special Coverage Products: Mechanical Technology

108 New on the Market

109 New on Disk

110 New Literature

112 Advertisers Index

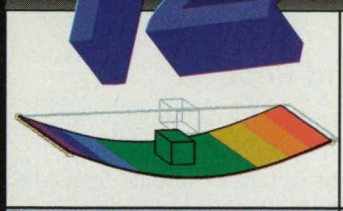


Starburr's Enterprises, a drafting and design firm in Salt Lake City, UT, created user-friendly manuals for a client who designs and markets remote-controlled racing cars. The hobbyists who purchase the cars receive a box containing about 200 parts, including nuts, screws, and bolts. Starburr's used AutoCAD Release 14 design software from Autodesk, San Rafael, CA, to develop drawings for the manuals, including 3D illustrations. The manuals consist of 23 drawings, like the one shown, that depict the assemblies as exploded views, allowing customers to visualize how the parts will fit together.

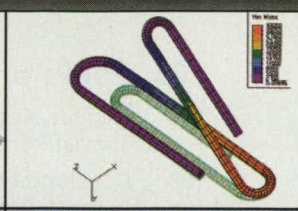
(Image courtesy of Autodesk)

Now: NONLINEAR that's EASY

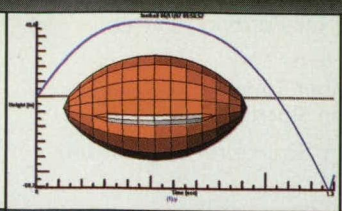
12 EASY things you can do with Nonlinear that you can't do with regular linear stress analysis



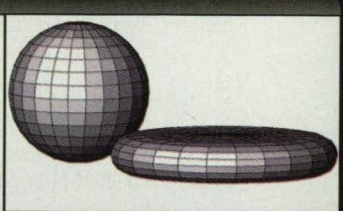
Out of plane bending - Use nonlinear analysis to determine whether this plate will foreshorten and fall out of its support. Linear cannot predict geometry changes perpendicular to a load.



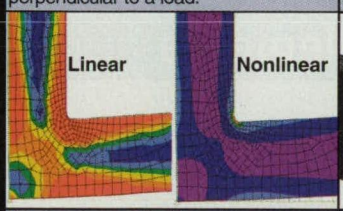
Permanent deformation - Algor's nonlinear analysis can predict the permanent deformation when the predicted stress exceeds the yield stress. Linear analysis can't do this.



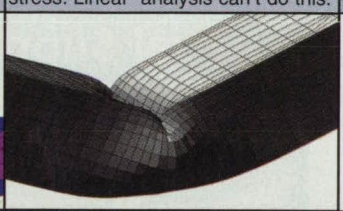
Trajectory - Basic motion, such as the trajectory of this rotating football is easily done using Algor's nonlinear analysis. Linear analysis cannot predict motion.



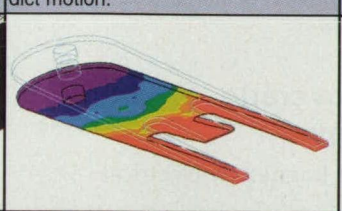
Squashing - Squashing this rubber ball in a vice using linear analysis cannot predict the final shape like this nonlinear analysis.



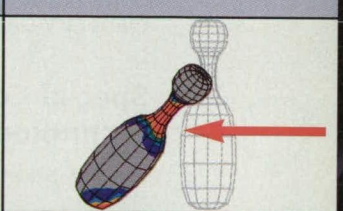
Stress concentration - Linear stress analysis will misrepresent both the stress and the deformation of this hanger due to minute changes in the fillet. Nonlinear analysis gets it right.



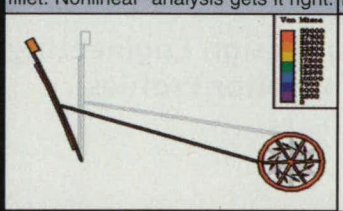
Local buckling - When failure is due to local buckling, the geometry fails at stresses much, much lower than the yield stress. Linear cannot detect local buckling.



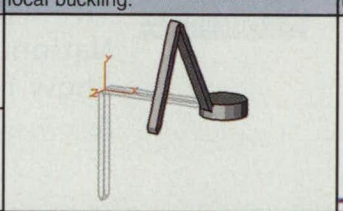
Snap-through - Any time you have a snap-through effect, your part is in motion until it stops on the other side. You need nonlinear analysis to predict this effect.



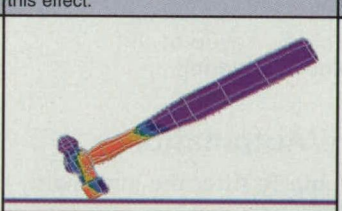
Impact - Nonlinear dynamic response predicts the stress in an object when it goes into motion as a result of impact by another object. Linear analysis cannot analyze for impact and motion.



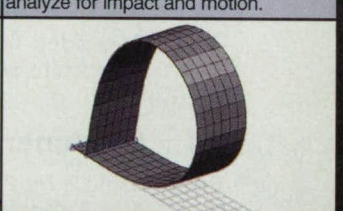
4-bar link - Linear dynamic analysis cannot predict the forces and stresses due to periodic loading. Accupak/VE simulates the loading and stresses in one analysis.



3-D mechanism - When a moving object is a 3-D mechanism, high inertia forces can occur. You need Accupak/VE to predict the stresses caused by motion.



Contact impact - Kinematic motion and the stresses due to the shock of impact cannot be predicted by either linear stress analysis or kinematics analysis software. Accupak/VE does it in one shot..



Elastic large deformation - Nonlinear analysis predicts the stressed geometry when the deformation is significant, even if the material properties remain linear. Linear analysis fails at this.

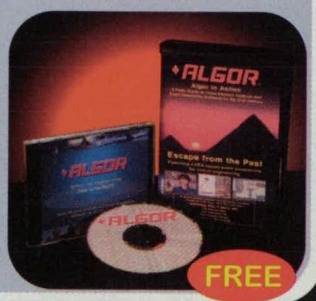
Nonlinear Dynamic Analysis for Virtual Engineering that's:

1. **As EASY as Linear Static Stress Analysis**
2. **At Linear Stress Pricing Levels**
3. **Fully Integrated with your CAD Station**

Accupak/VE from Algor is the nonlinear dynamic analysis software that's as easy to use as regular linear stress analysis while providing advanced solution technology. Its ease-of-use, affordability, and compatibility with Pentium computers and mainstream CAD systems make Accupak/VE ideal for everyday engineering. Engineers can learn it quickly and easily with the help of Docutech-Technical Documentation On-line Information Resource.

Get your free Video and CD-ROM to see Algor Software in action

Video includes 18 action packed minutes of real-world examples combined with Algor FEA demonstrations. See Accupak/VE in action. CD includes a complete version of Algor's website with detailed information and software you can try.



Visit Algor at:
WWW.ALGOR.COM

Products

Services

Download Superdraw III

You have 4 ways to get your free demo video and CD-ROM:

1) Call: +1 (412) 967-2700
2) WWW.ALGOR.COM
3) E-mail to: info@algor.com
4) Complete this form and fax to: +1 (412) 967-2781

Name _____ Company _____

Address _____

City _____ State/Prov. _____ Zip/Postal Code _____

Country _____ Telephone _____

Fax _____ E-mail _____

ALGOR®

When the Engineering Has to be Right

Algor, Inc.
150 Beta Drive, Pittsburgh, PA 15238-2932
USA
Phone: +1 (412) 967-2700
Fax: +1 (412) 967-2781
California: +1 (714) 564-0844
Europe (UK): +44 (1) (784) 442 246
E-mail: info@algor.com

Contents *continued*

66 Materials

66 Alumina/Ethanol Colloidal Suspensions for Seeding Hot Flows

66 Two Methods for Purifying Carbon Tetrachloride

68 Coating SiC Fiber Tows With Polymer/Silicon Slurries

69 Nitrogen-Beam Source for Deposition of III/V Nitrides

70 Computer Software

70 Software for Retrieval and Display of Planetary Data

72 Special Coverage: Mechanical Technology

72 Metal Gasket Bonded by Electrical Heating

72 Vertical Centrifugal Investment-Casting Machine

76 Gas Buffer Seal

78 Two-Sided Tools for Layup of Composite Sandwich Panels

84 Machinery/Automation

84 Using a Jet Pump To Alter the Inlet Swirl of a Turbopump

84 Adaptive Performance Optimization of Transport Aircraft

90 Manufacturing/Fabrication

90 Removable Fillers for VPS Fabrication of Closed Channels

92 Controlled-Orientation Short-Fiber Composite Bodies

94 Fabrication of Thin-Film Type-S Thermocouples

98 Mathematics and Information Sciences

98 Training of Neural Networks by Modified Taguchi Techniques

100 Expressing Object-Oriented Concepts in Fortran 90

102 LTI Approach to Adaptive Narrow-Band Feedforward Control

104 Improved Design of Adaptive Feedforward Tracking Systems

106 Books and Reports

106 Flexible Actuators for Small, Mobile, Special-Purpose Robots

106 Development of Small, Mobile, Special-Purpose Robots

Special Supplements

1a - 14a
Electronics Tech Briefs

Follows page 80 in selected editions only.

1N - 24N
National Design Engineering Show Exhibitor Profiles

Follows page 96.

On the cover:

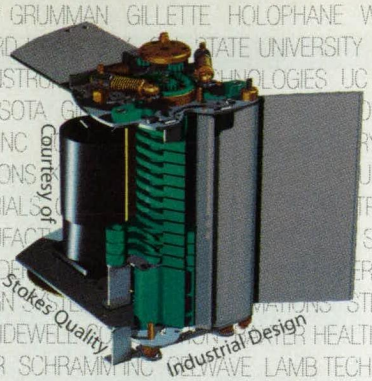
To minimize development time and costs when constructing physical prototypes, automobile manufacturers are turning to computer simulation software for digital assembly tests on their CAD components and assemblies. One such software, Virtual Workshop Version 4 from Tecoplan Informatik (Troy, MI), is used by auto makers BMW, Ford, Volvo, and Audi, which created this fly-through of the complex assemblies of a car design. The software's FlyVOX module enables real-time "flight" through or around the car. For more information on the Virtual Workshop and other advanced design software, see the Special Coverage on Computer-Aided Design and Engineering beginning on page 34.

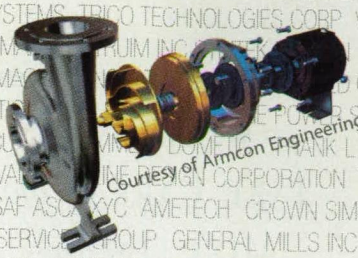
(Image courtesy of Tecoplan Informatik)

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither Associated Business Publications Co., Ltd. nor the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights. The U.S. Government does not endorse any commercial product, process, or activity identified in this publication.

Permissions: Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Associated Business Publications, provided that the flat fee of $3.00 per copy be paid directly to the Copyright Clearance Center (21 Congress St., Salem, MA 01970). For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is:

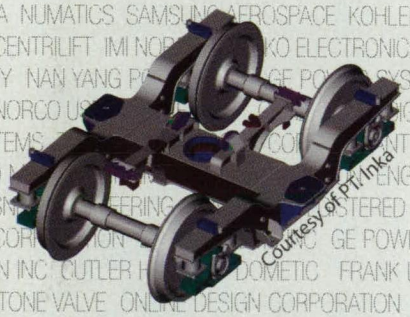
ISSN 0145-319X194 $3.00+ .00



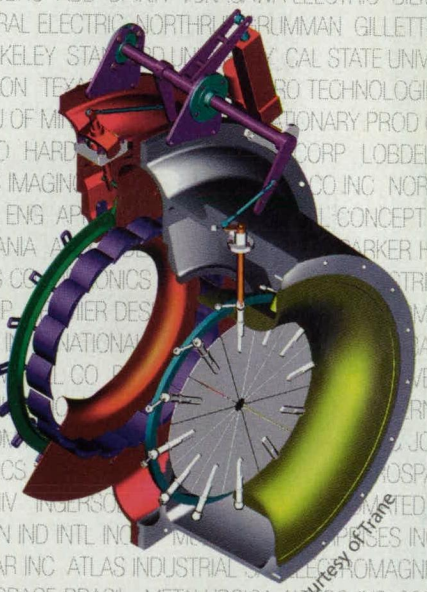


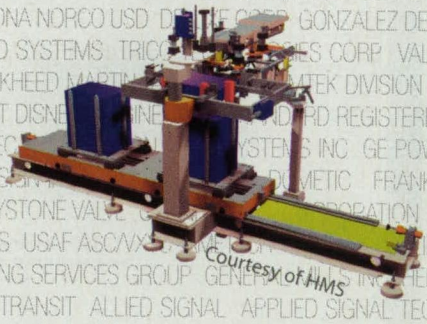
WORK LIKE THIS IS WHY MECHANICAL DESKTOP BECAME THE 5-TO-1 FAVORITE.

{ Introducing Mechanical Desktop® 2.0, how more design professionals are moving to 3D modeling. }



Everyone wants a shorter product-to-market cycle. That's why tens of thousands of engineers have already made Mechanical Desktop the best selling PC-based 3D modeling software. And now there's Mechanical Desktop 2.0, with all the benefits of feature-based parametric solid modeling, NURBS surface modeling, assembly modeling, associative drafting, as well as DWG compatibility. And you still have full 2D drafting capabilities.*





DESIGN YOUR WORLD™

Autodesk®

For a Free Demo CD, call 1-800-964-6432
Request Demo Pak #s467 or get information on education discounts. And visit www.autodesk.com/s467

© Copyright 1997 Autodesk, Inc. Autodesk, Mechanical Desktop and the Autodesk logo are registered trademarks of Autodesk, Inc. "Design Your World" is a trademark of Autodesk, Inc. All other trademarks belong to their respective owners. Background names are registered Mechanical Desktop users. *Source: Daratech, Inc. Midrange modeler installed base year-end 1996.

WHEN YOU TAKE CARE *of the* MINUTES, *the* HOURS TAKE CARE *of* THEMSELVES.

Time is fleeting. Whether it's time to market, or time to ponder, there's never enough of it. And while we can't add time to your day, we can help you save time, with modular, digital solutions to age-old document management problems.

Introducing the 8830 Digital Document System, the Xerox system solution designed to turn the traditional print-then-distribute paradigm on its head. A fully networked 8830 DDS makes it possible to decentralize document production and distribution—providing instant access to all walk-up and desktop users. The result: dramatically improved document accessibility, turnaround time, and overall productivity.

It's a process that saves days, weeks, even months in time and labor over the course of a project. Leaving you free to pursue other, more important goals. To learn more, call us at 1-800-XES TALK, ext. 1564. Or visit us at www.xerox.com/XES

8830 DIGITAL DOCUMENT SYSTEM

THE DOCUMENT COMPANY

XEROX

ENGINEERING SYSTEMS

For More Information Circle No. 536

Xerox® and 8830® are trademarks of Xerox Corporation. © 1997, Xerox Corporation

CONVERT COMPUTER GRAPHICS

TO VIDEO

- Up to 1600 x 1200 pixel input
- Analog output/ NTSC *and* PAL, S-Video, Y, $P_{B'}$ $P_{R'}$ RGB
- Digital output/ CCIR 601
- Selectable flicker filters
- Autosync
- Video overlay
- Pan & zoom
- RS-232 control
- Full 24-bit color
- Genlock
- Simple external connections

WE GIVE YOU MORE REASONS TO CHOOSE RGB/VIDEOLINK® SCAN CONVERTERS

Now you can transform computer graphics and other signals to broadcast standard video with RGB Spectrum's line of video scan converters.

RGB Spectrum, the leader in professional quality video scan conversion has designed the RGB/Videolink scan converter with a unique combination of quality and features to satisfy the most demanding user.

Visit our web site http://www.rgb.com

RGB SPECTRUM®
a visual communications company™
950 Marina Village Pkwy
Alameda, CA 94501
TEL (510) 814-7000
FAX (510) 814-7026
E-mail: sales@rgb.com

TECH BRIEFS

BPA ABP

Published by ..... Associated Business Publications
Chairman/Chief Executive Officer ..... Bill Schnirring; bill@abpi.net
Publisher ..... Joseph T. Pramberger
Associate Publisher, *Photonics Tech Briefs* ..... Linda Silver
Chief Editor ..... Linda L. Bell
Editor, Market Focus Editions ..... Robert Clark
Associate Editor ..... Suzanne Bilyeu
Production Manager ..... Margery Koen
Assistant Production Manager ..... John Iwanciw
Art Director ..... Lois Erlacher
Production Artists ..... Christopher Coleman, Alice Terry
Circulation Manager ..... Hugh J. Dowling
Assistant to Circulation Manager ..... Damiana Garcia

BRIEFS & SUPPORTING LITERATURE: Written and produced for NASA by **Advanced Testing Technologies, Inc.,** Hauppauge, NY 11788
Technical/Managing Editor ..... Ted Selinsky
Sr. Technical Analyst ..... Dr. Larry Grunberger
Art Manager ..... Eric Starstrom
Staff Writers/Editors ..... Dr. Theron Cole, George Watson
Graphics ..... Robert Simons
Editorial & Production ..... Joan Schmiemann, Becky D. Bentley

NASA:
NASA Tech Briefs are provided by the National Aeronautics and Space Administration, Technology Transfer Division, Washington, DC:
Administrator ..... Daniel S. Goldin
Director, Commercial Technology ..... Dr. Robert Norwood
Publications Director ..... Carl Ray

ASSOCIATED BUSINESS PUBLICATIONS
317 Madison Avenue, New York, NY 10017-5391
(212) 490-3999 FAX (212) 986-7864
Chairman/Chief Executive Officer ..... Bill Schnirring
President/Chief Operating Officer ..... Domenic A. Mucchetti
Executive Vice President ..... Joseph T. Pramberger
Credit/Collection ..... Felecia Lahey
Staff Accountant ..... Larry Duze
Budget Analyst ..... Mark Stanovic
Accounting Assistant ..... Alfredo Vasquez
Marketing Manager ..... Erving Dockery
Trade Show Coordinator ..... Melissa Hinnen
Exhibition Sales Representative ..... Joanna Lipton
Human Resources Manager ..... Lourdes Del Valle
MIS Manager ..... Ted Morawski
Webmaster ..... Albert Sunseri
Assistant MIS Manager ..... Pak Tong
Network Administrator ..... Dmitry Master
Office Manager ..... Sylvia Valentin
Mailroom Operations ..... John Torres, Rose D'Addozio
Administrative Assistant ..... Christine Saluzzi

***NASA TECH BRIEFS* ADVERTISING ACCOUNT EXECUTIVES**
Headquarters ..... (212) 490-3999
NY, CT, Eastern Canada ..... Diane G. Klusner at (212) 490-3999
PA, DE, NJ, VA, DC, MD ..... Tara Schelling at (212) 490-3999
MA, NH, ME, VT, RI ..... Dick Groth at (508) 553-0967
Southeast, South Central ..... Thomas E. Duffy at (770) 844-7996
OH, Western PA and NY, WV, Central Canada ..... Louise Clemens at (216) 397-7477
IL, WI, MO, IA, MN, ND, SD, NE, KS ..... Paul Tucker at (847) 397-7084
MI, IN, KY, Western OH ..... John Holmes at (847) 397-7084
N. Calif., CO ..... Bill Hague at (408) 492-9292
WA, OR, ID, MT, WY, UT, Western Canada ..... Bill Madden; Bill Hague at (253) 858-7575
S. Calif., NV ..... Blake Dahlgren at (310) 288-0391
AZ, NM ..... Linda Silver at (310) 247-0317
TechDeck Postcard Sales ..... Janet Krebs at (847) 397-7084

How To Reach Us On Line
NASA Tech Briefs home page: http://www.nasatech.com
To find out about advertising opportunities: ntb_advertise@mindspring.com
For circulation questions: hugh@abptuf.org
For production information: margery@abptuf.org

Imagine

performance worthy of a standing *ovation.*

Put your head in the clouds. Take your talents to a new heights with the award-winning Micron™ Powerdigm workstation. It's the perfect balance of performance, power and ingenuity. So perfect, *PC Magazine* named it the 1997 Workstation of the Year.

A masterwork station. Engineered by Micron, the Powerdigm is the quintessential scalable graphics solution. You'll render high-demand graphics, financial programs or CAD applications without boundaries. And none of our competitors can even come close.

No worries. Call us or visit our Web site now. We'll help you custom build a picture-perfect system, and our technical support dream team is here seven days a week, 24 hours a day. What's more, the Powerdigm is covered by an impressive warranty. It's a work of art. A stroke of genius. Micron Powerdigm. Imagine that.

POWERDIGM™

FEATURES AND OPTIONS
Supports dual processors
Supports IDE Ultra ATA and multiple Ultra Wide SCSI-3 hard drives
512KB pipeline burst cache, flash BIOS
Memory upgradable to 1GB ECC SDRAM
3Com Fast EtherNet 10/100 PCI network adapter
12/20X variable speed SCSI CD-ROM drive
Optional support for dual monitors
DMI, software and hardware management support
Wavetable stereo sound with speakers
Microsoft® IntelliMouse™
Microsoft Windows NT® Workstation
5-year/3-year Micron Power℠ limited warranty

POWERDIGM XSU

Intel 300MHz Pentium® II processor
Samurai™ chip set
Fire GL 1000 pro 8MB 66MHz PCI Open GL Professional 3D accelerator
4GB Ultra-Wide SCSI-3 hard drive
64MB ECC SDRAM
19" Hitachi SuperScan CM751 (18" display) .26dp monitor

$3,999
Bus. Lease **$127/mo.**

POWERDIGM XSU

Dual Intel 300MHz Pentium II processors
Samurai chip set
128MB ECC SDRAM
Fire GL 4000 15MB 3DRAM/16MB CDRAM
4GB Ultra-Wide SCSI-3 hard drive
Iomega 1GB Jaz SCSI drive
21" Hitachi SuperScan CM801 (20" display) .26dp monitor

$7,062
Bus. Lease **$224/mo.**

Call now to order.
888-669-0971
www.micronpc.com

MICRON ELECTRONICS™
Configured For Your Life™

Micron Sales Hrs: Mon-Fri 6am-10pm, Sat 7am-5pm, Sun 10am-5pm (MT); Technical Support Available 24 Hours A Day, 7 Days A Week; Toll-free from Mexico: 95-800-708-1755; Toll-free from Canada: 800-708-1758; Toll-free from Puerto Rico: 800-708-1756; International Sales: 208-893-8970; International Fax: 208-893-7393

©1998 Micron Electronics, Inc. All Rights reserved. Micron Electronics is not responsible for omissions or errors in typography or photography. All purchases are subject to availability. Prices and specifications may be changed without notice; prices do not include shipping and handling and any applicable taxes. 30-day money-back policy does not include return freight and original shipping/handling charges, applies only to Micron brand products and begins from date of shipment. All sales are subject to Micron Electronics' current terms and conditions of sale. Lease prices based on 36 month lease. The Intel Inside Logo and Pentium are registered trademarks and MMX is a trademark of Intel Corporation. Microsoft, Windows, Windows NT and the Windows logo are registered trademarks of Microsoft Corporation. Product names of Micron products are trademarks or registered trademarks of Micron Electronics, Inc., or NetFRAME Systems Incorporated. Other product names used in this publication are for identification purposes only and may be trademarks of their respective companies.

MMX™ intel inside pentium® II PROCESSOR

NASA Commercial Technology Team

NASA's R&D efforts produce a robust supply of promising technologies with applications in many industries. A key mechanism in identifying commercial applications for this technology is NASA's national network of commercial technology organizations. The network includes ten NASA field centers, six Regional Technology Transfer Centers (RTTCs), the National Technology Transfer Center (NTTC), business support organizations, and a full tie-in with the Federal Laboratory Consortium (FLC) for Technology Transfer. Call (206) 683-1005 for the FLC coordinator in your area.

NASA's Technology Sources

If you need further information about new technologies presented in *NASA Tech Briefs*, request the Technical Support Package (TSP) indicated at the end of the brief. If a TSP is not available, the Commercial Technology Office at the NASA field center that sponsored the research can provide you with additional information and, if applicable, refer you to the innovator(s). These centers are the source of all NASA-developed technology.

Ames Research Center
Selected technological strengths: Fluid Dynamics; Life Sciences; Earth and Atmospheric Sciences; Information, Communications, and Intelligent Systems; Human Factors.
Bruce Webbon
(650) 604-6646
bwebbon@mail.arc.nasa.gov

Dryden Flight Research Center
Selected technological strengths: Aerodynamics; Aeronautics Flight Testing; Aeropropulsion; Flight Systems; Thermal Testing; Integrated Systems Test and Validation.
Lee Duke
(805) 258-3802
duke@louie.dfrf.nasa.gov

Goddard Space Flight Center
Selected technological strengths: Earth and Planetary Science Missions; LIDAR; Cryogenic Systems; Tracking; Telemetry; Command.
George Alcorn
(301) 286-5810
galcorn@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths: Near/Deep-Space Mission Engineering; Microspacecraft; Space Communications; Information Systems; Remote Sensing; Robotics.
Merle McKenzie
(818) 354-2577
merle.mckenzie@ccmail.jpl.nasa.gov

Johnson Space Center
Selected technological strengths: Artificial Intelligence and Human Computer Interface; Life Sciences; Human Space Flight Operations; Avionics; Sensors; Communications.
Hank Davis
(713) 483-0474
hdavis@gp101.jsc.nasa.gov

Kennedy Space Center
Selected technological strengths: Environmental Monitoring; Sensors; Corrosion Protection; Bio-Sciences; Process Modeling; Work Planning/Control; Meteorology.
Gale Allen
(407) 867-6626
galeallen-1@ksc.nasa.gov

Langley Research Center
Selected technological strengths: Aerodynamics; Flight Systems; Materials; Structures; Sensors; Measurements; Information Sciences.
Dr. Joseph S. Heyman
(804) 864-6006
j.s.heyman@larc.nasa.gov

Lewis Research Center
Selected technological strengths: Aeropropulsion; Communications; Energy Technology; High Temperature Materials Research.
Larry Viterna
(216) 433-3484
cto@lerc.nasa.gov

Marshall Space Flight Center
Selected technological strengths: Materials; Manufacturing; Nondestructive Evaluation; Biotechnology; Space Propulsion; Controls and Dynamics; Structures; Microgravity Processing.
Sally Little
(205) 544-4266
sally.little@msfc.nasa.gov

Stennis Space Center
Selected technological strengths: Propulsion Systems; Test/Monitoring; Remote Sensing; Nonintrusive Instrumentation.
Kirk Sharp
(601) 688-1929
ksharp@ssc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the Regional Technology Transfer Center nearest you, call (800) 472-6785.

Joseph Allen
National Technology Transfer Center
(800) 678-6882

Ken Dozier
Far-West Technology Transfer Center
University of Southern California
(213) 743-2353

Dr. William Gasko
Center for Technology Commercialization
Massachusetts Technology Park
(508) 870-0042

J. Ronald Thornton
Southern Technology Applications Center
University of Florida
(904) 462-3913

Gary Sera
Mid-Continent Technology Transfer Center
Texas A&M University
(409) 845-8762

Lani S. Hummel
Mid-Atlantic Technology Applications Center
University of Pittsburgh
(412) 383-2500

Chris Coburn
Great Lakes Industrial Technology Transfer Center
Battelle Memorial Institute
(216) 734-0094

NASA ON-LINE: Go to NASA's Commercial Technology Network (CTN) on the World Wide Web at **http://nctn.hq.nasa.gov** to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

NASA Program Offices

At NASA Headquarters there are seven major program offices that develop and oversee technology projects of potential interest to industry. The street address for these strategic business units is: NASA Headquarters, 300 E St. SW, Washington, DC 20546.

Carl Ray
Small Business Innovation Research Program (SBIR) & Small Business Technology Transfer Program (STTR)
(202) 358-4652
cray@mail.hq.nasa.gov

Dr. Robert Norwood
Office of Aeronautics and Space Transportation Technology (Code R)
(202) 358-2320
rnorwood@mail.hq.nasa.gov

Philip Hodge
Office of Space Flight (Code M)
(202) 358-1417
phodge@osfms1.hq.nasa.gov

Gerald Johnson
Office of Aeronautics (Code R)
(202) 358-4711
g_johnson@aeromail.hq.nasa.gov

Bill Smith
Office of Space Sciences (Code S)
(202) 358-2473
wsmith@sm.ms.ossa.hq.nasa.gov

Bert Hansen
Office of Microgravity Science Applications (Code U)
(202) 358-1958
bhansen@gm.olmsa.hq.nasa.gov

Granville Paules
Office of Mission to Planet Earth (Code Y)
(202) 358-0706
gpaules@mtpe.hq.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

Dr. Jill Fabricant
Johnson Technology Commercialization Center
Houston, TX
(713) 335-1250

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
(216) 586-3888

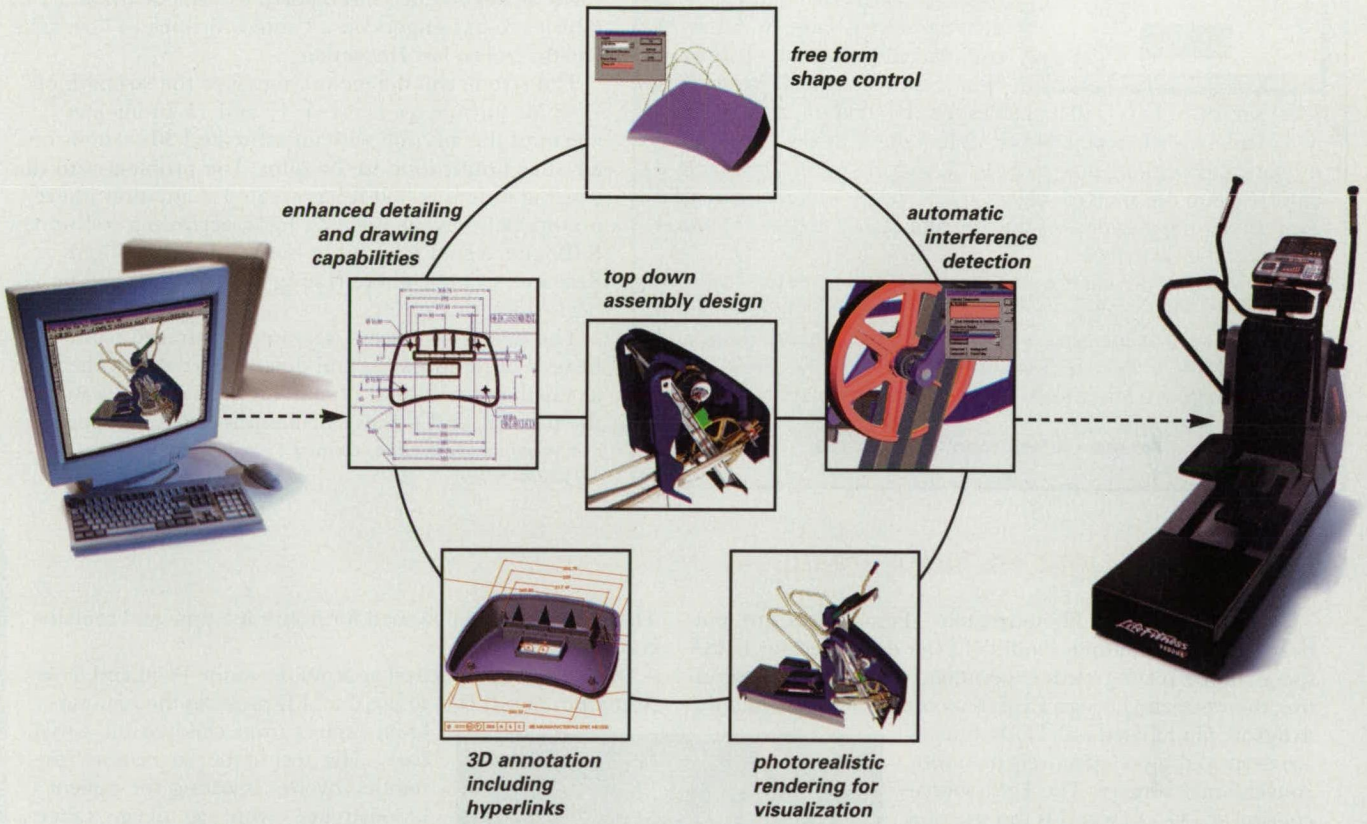
Joe Boeddeker
Ames Technology Commercialization Center
San Jose, CA
(408) 557-6700

Dan Morrison
Mississippi Enterprise for Technology
Stennis Space Center, MS
(800) 746-4699

If you are interested in information, applications, and services relating to satellite and aerial data for Earth resources, contact: Dr. Stan Morain, **Earth Analysis Center,** (505) 277-3622. For software developed with NASA funding, contact the **Computer Software Management and Information Center (COSMIC)** at phone: (706) 542-3265; Fax: (706) 542-4807; E-mail: http://www.cosmic.uga.edu or service@cosmic.uga.edu.

SOLID THINKING IS OFTEN WHY ONE PRODUCT WORKS AND ANOTHER ONE DOESN'T.

YOUR ABILITY TO QUICKLY TRANSFORM THAT THINKING FROM AN ENGINEER'S MIND TO A FINAL PRODUCT IS ALL THAT WILL REALLY MATTER.



A ▶ FOLD THIS SECTION OVER LEFT AND BACK SO "A" MEETS "B" ◀ B

What's the fastest route between point A and point B? For Life Fitness and their 9500HR Cross-Trainer, it was SolidWorks®. Since pioneering the world's first Windows-native 3D mechanical design software in 1995, we've earned a reputation as the leader in mainstream solid modeling. And in 1998, we add to our track record of innovation by unveiling a new set of flexible, easy-to-use features that helps you go from concept to reality without wasting time on repetitive tasks or costly modifications. Add to that local technical support and surprising affordability and you've got a product that can really help you make things. Like money, for instance. For more information, visit our Web site or call 800-693-9000, ext. 3041. SolidWorks. **Mind to Matter.**

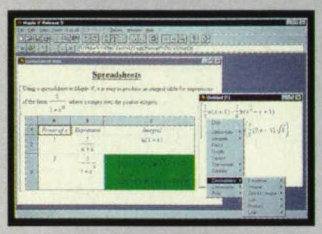
www.solidworks.com/3041

© Copyright 1998 SolidWorks Corporation. All rights reserved. SolidWorks is a registered trademark of SolidWorks Corporation. All other company and product names are trademarks or registered trademarks of their respective owners. Life Fitness Cross-Trainer courtesy of Life Fitness of Franklin Park, IL.

SolidWorks

UpFront

Product of the Month



Waterloo Maple, Waterloo, ON, Canada, has announced Release 5 of Maple V technical computing software that allows users to learn one interface but interact with a large number of commercially available packages. New features include a spreadsheet similar to Excel™ that enables creation of a spreadsheet within a Maple V worksheet; a MATLAB link that enables access to the numerical processing power of MATLAB from within the Maple V environment; the ability to create HTML pages with mathematical expressions and graphics for on-line publication; and an enhanced graphical user interface.

A new series of palettes provides a means to enter Maple V expressions. The palettes contain Greek symbols and mathematical constructs such as integrals, limits, summations, square roots, and powers. Maple V Release 5 is available for Windows 95/NT/3.1, Macintosh, Power Macintosh, UNIX, and Linux platforms. Single-user price is $1,195.

For More Information Circle No. 732

Making Your Skies Friendlier

Under a NASA contract, Coherent Technologies of Boulder, CO, is completing development and testing of an infrared Doppler radar system to detect clear air turbulence at cruise altitudes of commercial airliners. Clear air turbulence was blamed for one death and 102 injuries to passengers on a United Airlines 747 over the Pacific Ocean last December.

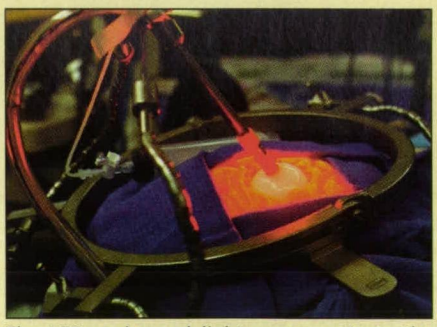
The system will detect and measure the strength of clear air turbulence between 10 and 15 kilometers ahead of the aircraft, with an estimated 30 seconds of advance notification to the pilot. The problem with the existing system is that it has created a situation where no one believes the warning light, according to Rodney K. Bogue, a staff scientist at NASA's Dryden Flight Research Center, where testing of the system will be performed this spring.

The new system uses lasers in the infrared band instead of radio waves, and detects particles in the air as small as a millionth of a meter in diameter, watches them move, and makes calculations about air speed.

For more information, contact Coherent Technologies at 303-604-2000.

NASA Shines Light on Tumor Treatment

A treatment called Photodynamic Therapy uses tiny pinhead-sized light-emitting diodes (LEDs) developed for NASA space shuttle plant growth experiments to activate light-sensitive, tumor-treating drugs. Experiments indicate that when the drugs are illuminated with LEDs, tumors are destroyed more effectively than with conventional surgery. The light source consists of 144 LEDs and is the size of a small human finger, about 1/2" in diameter. The light source and cooling system is the size of a medium suitcase.



The LED probe and light source activate the Photofrin II drug, destroying the tumor tissues, but leaving the delicate brain stem untouched.

Through the Small Business Innovation Research (SBIR) program, NASA funded contracts to demonstrate the feasibility of using LEDs in cancer treatment. The program, managed by NASA's Marshall Space Flight Center, involves LEDs manufactured by Quantum Devices of Barnevald, WI. The LEDs, first intended for use in food growth experiments in space, form the tip of a new 9" neural probe that illuminates through all nearby tissues, according to Dr. Harry Whalen, pediatric neurologist at the Children's Hospital of Wisconsin, and professor of neurology at the Medical College of Milwaukee.

"We've used lasers, too, but they are often unreliable and limited in color spectrum," said Dr. Whalen. "Lasers are also very expensive and lose power in their fiber-optic cables." The LED probe can be used for hours at a time and remains cool to the touch.

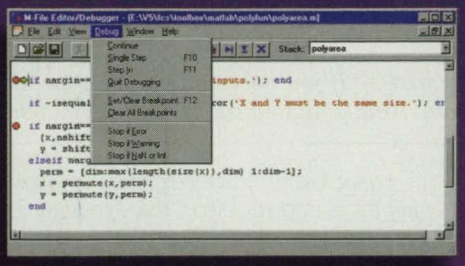
Dr. Whalen has received approval from the Food and Drug Administration (FDA) to use the LED probe in the removal of brain tumors from children on a trial basis. His technique to remove the tumors involves injecting the patient's bloodstream with a drug called Photofrin II, which attaches to the unwanted tissues and permeates them, leaving the surrounding tissues unaffected. The LED probe is then placed near the affected tissue to illuminate the tumor and activate the drug. Once activated by the light, the drug destroys the tumor's cells, leaving the brain stem tissues virtually untouched.

Dr. Whalen expects full approval of the technique, which could be the operating technique of the future. "The LED technology developed by NASA offers new hope to children with cancer," he said. "Every one of our cases will be a critical case with no hopeful alternatives. We think this probe will help give children with tumors a chance to live healthy, happy lives."

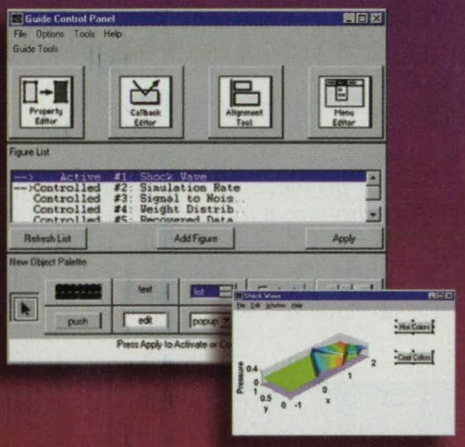
For more information, contact the NASA Marshall Technology Transfer Office at 205-544-4266 or visit the web site at http://techtran.msfc.nasa.gov

Correction

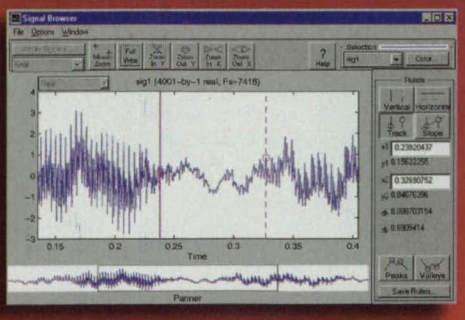
In Application Briefs in the December 1997 issue (page 22), we incorrectly reported that Brian K. Cooper of NASA's Jet Propulsion Laboratory used Virtual Binoculars from n-Vision to drive the Sojourner rover over the Martian terrain. Cooper, the primary rover driver for the Mars Pathfinder project, used Stereographics Crystal Eyes goggles and a custom program he wrote called the Rover Control Workstation running on a Silicon Graphics Onyx2 computer. The n-Vision binoculars were used to scan images of the Martian landscape obtained from cameras mounted on the rover.



Application Development Tools
"We initially coded algorithms in MATLAB and then converted the MATLAB source to C or C++. To our surprise, the MATLAB code was faster in nearly all cases."
Jack Staub
Hughes Aircraft



Interactive GUI Design
"In one day, I wrote 875 lines of MATLAB which equates to 5,000 lines of C code. I had a functioning GUI in one day. You can't do that with C."
Kathleen Splaine
Risk International



Analysis and Visualization
"Anything from simple analysis to complex modeling and simulation can be done in a fraction of the time it would take to write your own code."
Gregory E. Chamitoff, Ph.D.
NASA, Johnson Space Center

We wrote exactly 698,794 lines of C code so that you don't have to.

More than 400,000 engineers and scientists use MATLAB to accelerate their technical programming. Here's why.

Faster programming

Today's most productive technical professionals have one thing in common – they use MATLAB instead of C or C++. Because, unlike a general purpose language, MATLAB is a complete, integrated analysis, visualization, modeling, and development environment specifically designed for technical computing. So development goes much faster and code is dramatically shorter.

More numerical power built in

At the heart of MATLAB is an easy to learn technical computing language with more than 500 functions built in. The MATLAB language includes flow control, multidimensional arrays, user-defined structures, ASCII and binary external data file access, and much more. And you'll save even more time with MATLAB Toolboxes, collections of highly optimized, discipline-specific functions written by world-class experts. You can even link in C, C++, and Fortran routines.

MATLAB 5 COMPILER NOW AVAILABLE

Less time coding means more time to think

Put simply, use MATLAB and it will take you far less time to develop finely tuned applications with revealing graphics, custom GUIs, and compact maintainable code. Now just imagine what you can do with the time you save.

See how MATLAB 5 can help you work faster. Visit our Web site for demos, examples, and updating information.

The MATH WORKS Inc.

MATLAB®
www.mathworks.com/ntbm
call 508-647-7000
e-mail info@mathworks.com

The MathWorks, Inc. 24 Prime Park Way, Natick, MA 01760 Fax 508-647-7001
Employment opportunities: http://www.mathworks.com/newjobs.html

The MathWorks is represented in the following countries: **Australia:** + 61-2-9922-6311 • **Benelux:** + 31(0)182-53-7644 • **Brazil:** + 55-11-816-3144 **Czech Republic:** 42-(0)2-68-44-174 • **France:** 33-141-14-67-14 • **Germany/Austria:** + 49-241-470750 • **India:** + 91-80-5-549338 **Israel:** + 972-3-561-5151 • **Italy:** + 39-11-240-80-00 • **Japan:** + 81-3-5978-5410 • **Korea:** + 82-2-556-1257 • **New Zealand:** + 64-7-839-9102 **Nordic Countries:** + 46-8-15-30-22 • **Poland:** + 48-126-17-33-48 • **Singapore/Malaysia:** + 65-842-4222 • **South Africa:** + 27-11-325-6238 **Spain/Portugal:** + 34(9)3-415-49-04 • **Switzerland:** + 41-31-954-2020 • **Taiwan:** 886-2-505-0525 • **United Kingdom/Ireland:** + 44-1223-423-200

© 1998 by The MathWorks, Inc. All rights reserved. MATLAB is a registered trademark of The MathWorks, Inc. Other product or brand names are trademarks or registered trademarks of their respective holders.

Reader Forum

Reader Forum is devoted to the thoughts, concerns, questions, and comments of our readers. If you have a comment, a question regarding a specific technical problem, or an answer to a question that appeared in a recent issue, send your letter to the address below.

I'm writing in response to a Reader Forum letter that appeared in the January 1998 issue from Jack Botts of Square D. Mr. Botts was seeking manufacturers of thin-wall tubes to meet MIL-Specs. Our company, MicroML, manufactures polyimide thin-wall tubing, as well as custom tubing available in a variety of materials that can be made to any specs. I can be reached at MicoML at 718-886-0769.

Joseph Ciaccio
MicroML
College Point, NY

*(**Editor's Note:** The following two letters were posted on Reader Forum on the NASA Tech Briefs web site. To respond to these requests, visit Reader Forum at www.nasatech.com, or send your response via mail or fax to the address below.)*

Does anyone have a suggestion on how to move a corrosive fluid with a device that would use no moving parts? I'm looking for something other than an electromagnetic pump, and which would not use heat-induced convection.

Donald Horkheimer

I am looking for an inexpensive coating that can be bonded to plastic film to measure ultraviolet (UV) exposure over time. The coating would start opaque and fade to translucent over 2,000 hours of UV exposure. Any help would be appreciated.

Barry Austin

I have lost my voice box, and I am looking for electronic devices that I could build to help me communicate with others. I have a device called Servox, but it cannot be used outdoors with good results. Thanks.

Samuel Carlson
Carlson R&D
Bronx, NY

*(**Editor's Note:** A number of you have requested information on where to obtain the Mattel HotWheels Mars Rover. Mattel tells us that the demand is so great for this item that they must increase production since stores are running out of it quickly. They advise customers to keep checking with their local stores. You also may want to consult the HotWheels web site at: www.hotwheels.com for more information.)*

Post your letters to **Reader Forum** on-line at: **www.nasatech.com** or send to: Editor, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017; Fax: 212-986-7864. Please include your name, company (if applicable), address, and phone number or e-mail address.

Power•acPlus™
SCREWS AND TRAVEL NUTS

Nook Power•acPlus™ screws and custom travel nuts meet your design criteria for accuracy, smoothness, and precision quality components for repeatable linear delivery systems.

- Reliable Power•ac™ precision screws.
- 1/4" through 5/8" diameters.
- End machining.
- Custom acetal plastic nuts.
- Anti- or Zero Backlash features available.
- Prototypes or production quantities.
- Rapid Response from order to delivery.

Call (415) 593-5196 ask for "Power•acPlus™".

NATIONAL DESIGN ENGINEERING SHOW - SEE US AT BOOTH #205

NOOK ...THE LINEAR MOTION PEOPLE

NOOK INDUSTRIES, INC. CLEVELAND: (800) 321-7800 • FAX: (216) 271-7020 • E-MAIL: CHIEFENG@NOOKIND.COM
SAN FRANCISCO: (415) 593-5196 • FAX (415) 593-5197 • WEBSITE: NOOKIND.COM

www.sgi.com/go/workstations

Performance defined by Zero Tolerance.

THE POWER TO VISUALIZE PERFECTION.

More manufacturers are visualizing their alternatives when failure is not an option. Silicon Graphics® computer systems are the most powerful means of doing just that. Industry-leading graphics, innovative applications and enhanced CPU performance give companies the edge of complete digital design and manufacturing techniques.

Silicon Graphics O2,™ OCTANE™ and Onyx2™ workstations comprise the broadest range of scalable high-performance platforms. Tackle tougher problems including digital prototyping/mockup, concurrent engineering and simulations. Interact with large assemblies, perform more iterations of complex analyses. Focus more clearly on any problem. Turn data into understanding, understanding into insight. Visualize your success in ways only possible with Silicon Graphics.

Desktop Performers.
The O2 and OCTANE workstation solutions starting at $5902*.

at the core of design

SiliconGraphics

© 1998 Silicon Graphics, Inc. All rights reserved. Silicon Graphics and Onyx are registered trademarks, and O2, OCTANE, Onyx2 and the Silicon Graphics logo are trademarks, of Silicon Graphics, Inc. Concept car courtesy of Unigraphics.

* Price quoted is valid for U.S. only.

For More Information Circle No. 572

There are a ton of reasons to use Vespel® just about anywhere.

The reasons to use Vespel® polyimide parts and shapes keep piling up. And not just because they stand up to heat, friction, pressure and aggressive environments – with minimal or no lubrication. Manufacturers are finding that Vespel® parts in a wide range of applications can really trim the bottom line. That's because the reliability and long life of Vespel® parts can make them the most cost-effective choice for general applications in the long term.

If your applications require parts that can withstand extreme temperatures (cryogenic to 550 F), Vespel® should be your first choice. Vespel® should also be considered for parts that rub together, if metal parts are too noisy, or if fluid flow needs to be controlled.

Superior performance and reliability aren't the only ways Vespel® can save you money. Often, you can consolidate two or more existing parts in one Vespel® piece.

Seal Rings.

In the assembly of automobile transmissions, and farm and construction equipment, Vespel® seal rings reduce costs by replacing expensive metal rings, which can fracture or deform during assembly. They also reduce warranty costs by producing a better seal.

Bushings.

In aircraft engine vanes, Vespel® bushings withstand high-frequency vibration dithering and offer excellent stability and lubricity at extreme temperatures. They also reduce assembly time.

Thrust Devices.

The automotive industry counts on Vespel® thrust devices because they reduce friction, extend component life and can be easily molded. What's more, the variety of Vespel® grades allows manufacturers to specify the properties they need most.

Insulators.

In plasma-arc cutting torches, Vespel® insulators provide superior strength and durability at high temperatures up to 550 F, lasting up to six times longer than fragile ceramic insulators.

Thrust Washers.

In construction equipment transmissions, Vespel® thrust washers reduce costs and manufacturing time by eliminating the need for secondary machining. Vespel® washers also withstand high pressure and exhibit minimal wear with limited or no lubrication.

Compressor Discus Valves.

Supermarkets are cooling foods more efficiently with discus compressors, featuring components made of Vespel.® Vespel® not only reduces energy and noise levels, but it also offers excellent wear resistance. The Vespel® part is expected to operate for 15 years without failure.

Stripper Fingers.

Thanks to its high temperature resistance, Vespel® parts are ideal for copier stripper fingers. The Vespel® fingers resist heat as well as toner buildup, allowing a greater number of copies without part changes.

And Vespel® parts can be direct-formed, which eliminates machining costs.

When you consider how cost-effective Vespel® parts can be in the long term, it's clear that we don't just make better bushings, bearings, washers and seals. We make better sense.

www.dupont.com/enggpolymers

IF YOU WANT TO GET TECHNICAL

For information, call 1-800-426-7246. Or write: DuPont Vespel® Product Information Center, P.O. Box 1138, Bloomfield Hills, MI 48303-1138.

DUPONT®

Vespel®

Polyimide Parts and Shapes

For More Information Circle No. 529

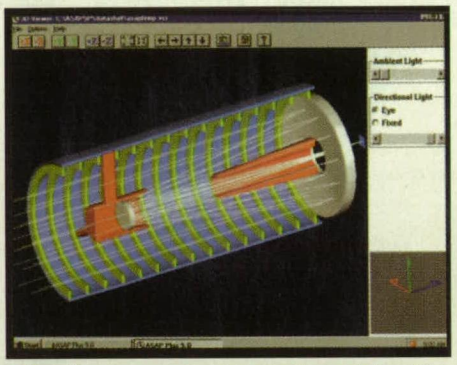
CAD/CAM Software

This month, in our year-long celebration of NASA's 40th Anniversary, we take a look at successful spinoff products and new applications of NASA technologies in the area of CAD/CAM Software.

1970s

"Illuminating" Optical Design Solutions

In the early 1970s, Robert P. Breault was a graduate student at the University of Arizona working on a project supported by a contract with NASA's Marshall Space Flight Center. The project involved performing stray light analysis, an infrequent occurrence in a system design. And while stray light analysis is a relatively common procedure today, it was thought of as an impossible task 25 years ago. It seemed like "black magic" to some, according to Breault. That project, in its pioneering stages, was the Hubble Space Telescope.



ASAP allows users to automatically model multiple light sources at many different wavelengths. This telescope model features color rendering and wireframes, combined with graphical ray traces, to provide clear illustration of system geometry and performance.

Breault's work led to the reduction of stray light background on the Hubble by a factor of 100,000 from the original design, and also led to the creation of APART stray light analysis software, now considered the industry standard.

The university's contract with NASA ended in 1974. But by then, Breault had already begun to develop a list of clients for which he provided consulting in stray light analysis with the help of two fellow graduate students. Breault's booming three-man business generated more contracts and more successes, giving him a reputation for expertise in stray light analysis.

About that time, Breault stumbled onto a notice announcing a seminar on starting your own small business, which he did in 1975, forming a sole proprietorship. Five years later, when he left the University of Arizona, Breault had to decide whether to enter the business world as someone's employee, or to start a business of his own. Breault Research Organization (BRO), of which he is the founder and current president, was incorporated by Bob Breault in 1979.

APART, the software that Breault had developed through his work at the university, still had some shortfalls that needed to be addressed. He enlisted the help of Alan Greynolds, one of the graduate students who had worked with Breault at the university. Greynolds created the Advanced Systems Analysis Program (ASAP) to solve those problems. ASAP soon gained a life of its own and is now an award-winning program that performs geometrical and physical optical analysis of general optical systems in full 3D geometry.

Breault credits his early work on NASA-funded projects for much of his company's current success. "By getting the contract from NASA Marshall, it developed my reputation and expertise. By the time I left the university in 1979, I had a customer base and list of credentials that were quite remarkable for a graduate student. I never worked in industry for anybody else," he said. "That experience led directly to the creation of Breault Research."

The company's ties with NASA go beyond Breault's work. Robert J. Pagano, vice president of BRO's Optical Engineering Services Group, worked at NASA's Jet Propulsion Laboratory, where he was a member of a project management team responsible for the development of an earth-orbiting atmospheric sounder, and was lead optical engineer for a wide-field imaging sensor employing eight refractive cameras and a multi-pass laser absorption spectrometer for the Saturn Orbiter/Titan Probe.

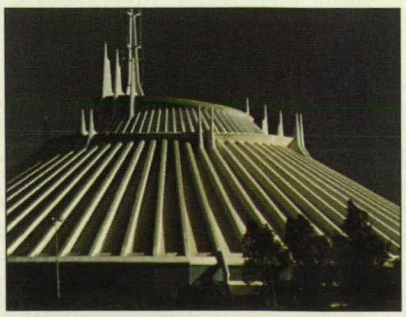
In addition, BRO has been involved in almost every major phase of the Hubble Space Telescope project, from the first contract with the University of Arizona, to the evaluation of the Hubble's initial problems after launch, to the solution of the problem, which involved the use of both the ASAP and APART software programs.

Today, BRO is located near the University of Arizona's Optical Sciences Center in Tucson, and holds a leadership position in the area of optical design and analysis. APART is now the industry standard for stray light analysis and is used by NASA and most aerospace companies worldwide. Stray light concepts borne out of APART are now built into ASAP, the optical engineering program that is used in a range of applications where optics are used or designed, including projection systems, medical equipment, telescopes, satellite systems, light bulbs, cameras, remote sensing instruments, automotive headlamps, and computer flat-screen displays.

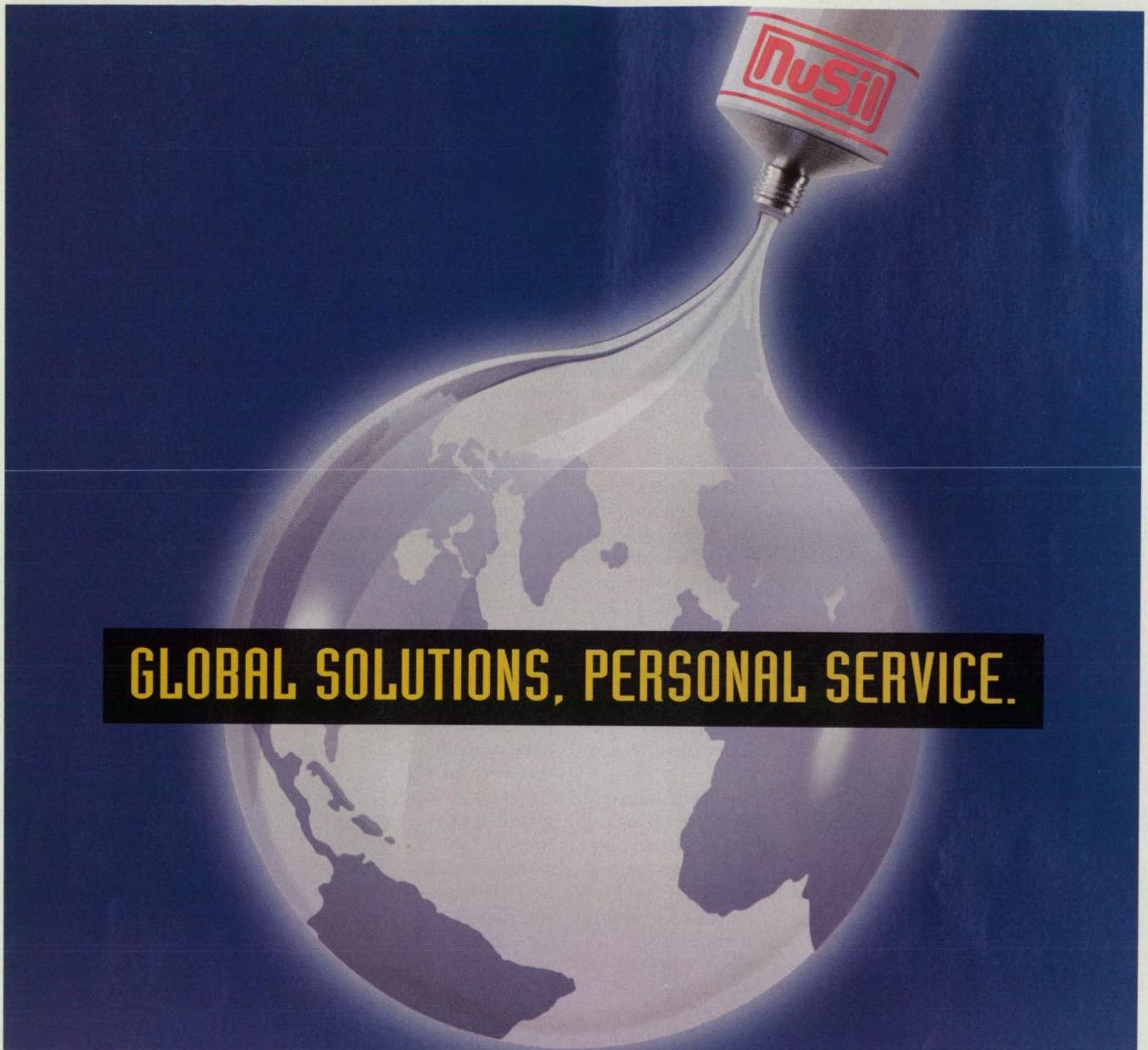
Seventy-five percent of BRO's business is commercial, according to Breault. And that success is a direct result of his work with NASA. "Our commercial business is tied directly to the stray light analysis experience for NASA," he said. "NASA really took a risk on a young graduate student."

NASA Helps Create Cadillacs and Coasters

In 1965, NASA sponsored a project to develop a software program that would provide a unified approach to computerized structural analysis. The resulting software was called NASA Structural Analysis Program, or NASTRAN. The program was developed by NASA's Goddard Space Flight Center for spacecraft design, mathematically analyzing a design and predicting how



The support structure for Disney World's Space Mountain roller coaster was designed with help from NASTRAN.



GLOBAL SOLUTIONS, PERSONAL SERVICE.

As a reliable developer, manufacturer, and supplier of advanced silicone materials, NuSil Technology provides what other silicone companies might lack: personal service. When you choose NuSil, you get more than just a product. We offer unparalleled quality, coupled with global technical support, and can handle all of your silicone needs on a personal basis.

For over 15 years, NuSil Technology has satisfied the changing demands in all aspects of the silicone industry. As an ISO-9001 certified company, we provide solutions for specific design problems encountered in the aerospace, health care, and other high-technology industries, as well as for the smaller silicone user. And, our consistent quality assures total reliability, traceability, and lot-to-lot reproducibility.

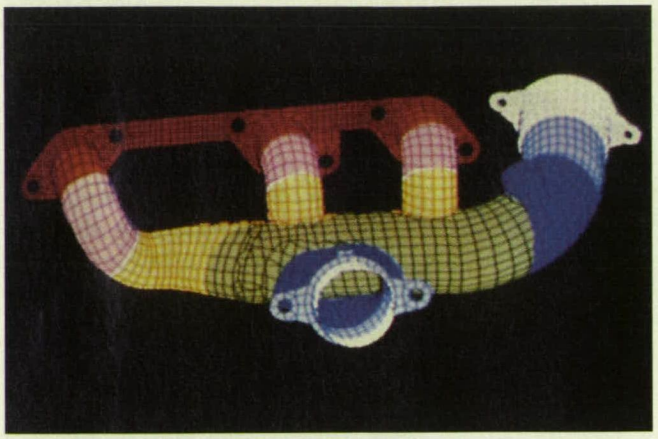
So, when you decide to change your world with silicone, call or write NuSil Technology. We take your application requirements seriously — and personally.

NuSil SILICONE TECHNOLOGY

NuSil Technology
1050 Cindy Lane
Carpinteria, CA 93013, U.S.A.
(805) 684-8780 • Fax (805) 684-2365

NuSil Technology — Europe
Atlantic Parc - Les Pyramides No. 5
P.A. de Maignon 64600 Anglet, FRANCE
+33 (0)5 59 31 41 04 • Fax +33 (0)5 59 31 41 05

For More Information Circle No. 531



This image, developed with NASTRAN, shows temperature distribution of an exhaust manifold. Red areas are the hottest.

it will perform under particular stresses and strains.

NASTRAN turned out to be one of the most widely used NASA software programs ever developed. It has been applied to automobile design — most U.S. auto makers employ NASTRAN or other NASA-developed software in their design processes — as well as trucks, railroad cars, ships, steam turbines, bridges, office buildings, and machine tools. It was even used in the design of the appropriately named "Space Mountain" roller coaster at Florida's Walt Disney World.

Designed by WED Enterprises, a division of Walt Disney Productions, Space Mountain required a support structure for the tracks that would be safe, but not overstrong. WED chose NASTRAN to simplify analysis of the structure, saving labor time and materials.

There are hundreds of other examples in which industry has used NASTRAN, including the design of General Motors' Cadillac Seville. Honda R&D Computer Ltd. used NASTRAN for more than a decade in structural analysis of auto bodies, motorcycles, tires, wheels, and engines, and Ford Motor Co. used it to analyze auto frame buckling and stress, and static analyses of suspension components.

One of the companies participating in the 1965 NASA project was MacNeal-Schwendler Corp. (MSC) of Los Angeles, CA. MSC licensed the NASA technology and developed a proprietary version of NASTRAN — MSC/NASTRAN — which was introduced to the commercial market in 1971. The software, now available for Windows, is in Version 70 today.

visible. The Hidden Line Computer Code, developed by Hedgley, removed superfluous lines and allowed the computer to display an object from a specific point of view — exactly how a human would see it. In 1982, the program became available to the commercial market. In its first year, the Hidden Line Computer Code was a best-seller through NASA's Computer Software Management and Information Center (COSMIC®), which supplies government-developed software adaptable to secondary uses in industry.

Simulation Spinoff

In 1989, Steve Lakowske founded Coryphaeus Software in Los Gatos, CA, a manufacturer of real-time 3D simulation software. His previous experience was as an electronics engineer at NASA's Ames Research Center, where he worked for ten years on projects such as a vertical motion simulator and other human/machine interaction projects.

Lakowske took his NASA software experience to Coryphaeus, which today produces high-end, real-time simulation products for virtual reality applications, with annual sales of over $6 million. The company's flagship product, Designer's Workbench™, is a modeling and simulation tool for development of static and dynamic 3D databases. EasyT™ lets users create massive, realistic representations of Earth terrain from imported satellite data, and allows the user to fly through or over models. EasyScene™ software controls actions among interactive objects in a virtual world.

Coryphaeus software allows creation of real-time 3D visual simulations for training jet pilots.

Coryphaeus' products are designed for both engineering and non-programming users to build 3D real-time simulations. The products have been used in the aerospace, aviation, architectural, and engineering fields by companies such as Boeing, Hughes Training, Lockheed Martin, ITT Automotive, NASA, and the U.S. military.

1980s

Solving a Hidden Problem

David R. Hedgley, Jr., a mathematician at NASA's Dryden Flight Research Center, solved a problem in 1981 that had been faced by designers using computer-generated graphics in aerospace, architecture, auto development, and other fields of design. The problem: A computer cannot see a solid object as the human eye sees it. It defines the whole object without perspective. So if you're looking at a desk, you'll see the top and one or two sides, depending on your angle of view. A computer, however, when asked to produce a picture of the same desk, would show all of the surfaces, angles, curves, and parts that the human viewer can't see. The result was a confusing, cluttered graphic that complicated the design process.

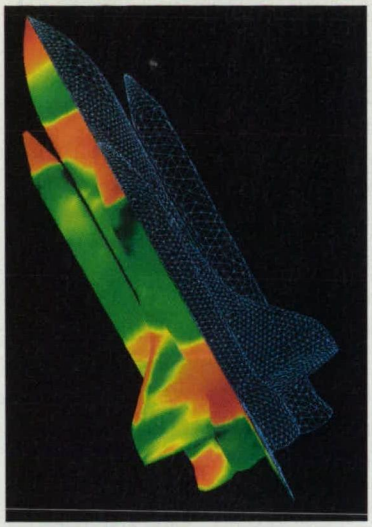
The solution: a computer program that considers whether a line in a graphic model of a 3D object should or should not be

1990s

NASA Advances CFD Design

NASA's Small Business Innovation Research (SBIR) program encourages companies to pursue research on new concepts and seek to commercialize the end product. ViGYAN — an aerospace, environmental, and data processing services firm in Hampton, VA — did just that. In 1979, the company received its first SBIR grant from NASA's Langley Research Center, which subsequently awarded ViGYAN other SBIR contracts to develop software for computer simulation of flight vehicle configurations.

The resulting software from the initial contract are two programs, VGRID3D and VPLOT3D, which incorporate the aerospace design technique known as computational fluid dynamics (CFD). Aeronautical design engineers create

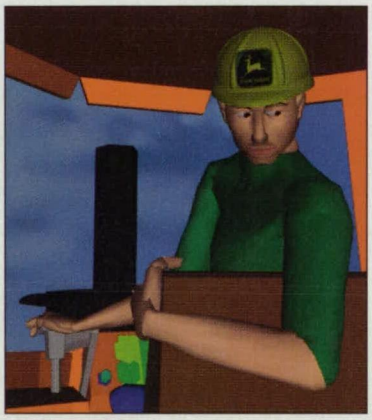


VGRID3D was used to generate unstructured grids around this 3D configuration of the space shuttle.

mathematical models of flight vehicles, and use computer simulation to virtually "fly" them. CFD is used where the flow over a 3D configuration is simulated using mathematical equations.

CFD uses a structured set of lines in three coordinate directions — a structured grid — represented by clusters of points, lines, and surfaces. Equations are numerically solved at these points. An alternative technique — unstructured grids — efficiently incorporates adaptive refinement and moving boundaries to offer better control over the grid size and point clustering. The new technique was employed in VGRID3D and VPLOT3D.

See Jack Run



Meet Jack. Jack is an advanced human factors software package for CAD applications and is the result of more than ten years of research by the Computer Graphics Research Laboratory at the University of Pennsylvania. The original investor in the Jack development effort was NASA's Johnson Space Center, which presented Jack with its first real-world problems to solve, and continued to provide data to the University for use in later versions of Jack.

Jack was used in the development and evaluation of an Army helicopter and other military vehicles, and played a role in human factors design of a line of Deere & Company's earth-moving equipment.

While still in use at the University of Pennsylvania, commercial rights to Jack were obtained by Transom Technologies of Ann Arbor, MI. Now named Transom Jack, it is a real-time visual simulation tool that allows users to create virtual environments by incorporating data or creating objects, populating the environment with biomechanically accurate human figures, and observing their behavior.

The realistic human figure has 74 segments, 73 joints, a realistic spine, and 150 degrees of freedom. Transom Jack's movements are so human-like that if he is made to reach for something too far away that pulls him off-balance, he will take a step to regain his balance, exactly the way a real person would.

Transom Jack can help designers determine, for example, if a human pilot will fit comfortably in a cockpit design, if he or she would have accurate field of vision, and if the pilot could reach the controls. Since its commercialization, NASA has used Transom Jack to determine if tools could be reached by virtual astronauts.

Strengths and Weaknesses

Ceramics are one of the alternative materials that are stronger and lighter than metals, and are resistant to high temperatures. Because of these properties, they have found uses in aerospace propulsion systems, and in products subjected to excessive stress or wear, such as valves, cutting tools, bearings, and artificial hip and knee joints. Advances in ceramic processing and composition have made them more attractive, but they are still inherently brittle and vary in strength behavior.

A way of determining, in a product's design phase, what the effects will be of stress and fatigue on a part; identifying potential failure modes; and predicting the life of the part was still needed. NASA's Lewis Research Center began work on such a product in the late 1970s to meet ceramics development requirements of NASA, the Department of Energy, other government agencies, and industry.

This CARES/LIFE plot shows stress levels on a turbine blade.

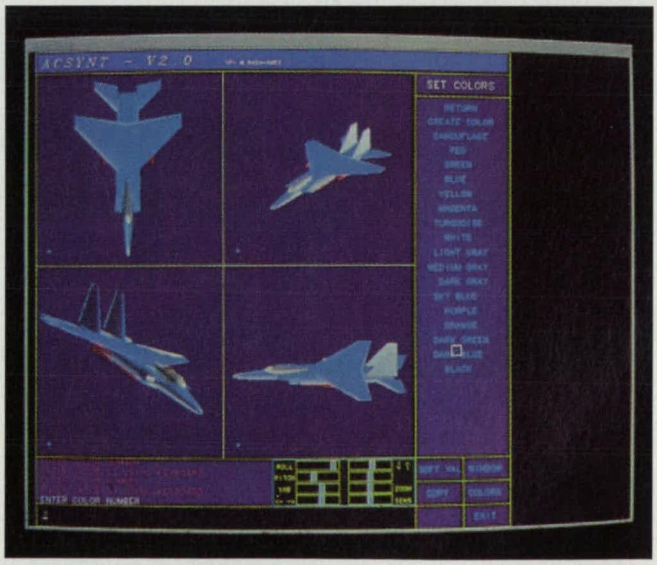
The resulting software, released more than 15 years later, accurately predicts the performance of brittle structures over time. A winner of NASA's Software of the Year Award, Ceramic Analysis and Reliability Evaluation of Structures (CARES) software now is used worldwide in designing turbojet engines, auto and truck engine valves, computer chips, and cathode ray tubes.

The CARES program simulates tests of ceramic components, enabling a designer to test various configurations for failure probability, and adjust the structure's geometry to minimize the predicted failure or maximize durability. A newer version of the software — CARES/LIFE — was released in 1995, with the added capability of lifetime prediction.

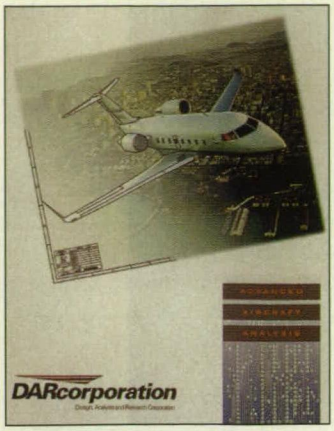
Aiding Aircraft Design

Two software programs developed with help from NASA are making aircraft design a more accurate — and cost-effective — process.

In the 1970s, NASA's Ames Research Center initiated design of the AirCraft SYNThesis (ACSYNT) tool to improve the con-



Using ACSYNT, aircraft designers can enter component dimensions and have surfaces created automatically.



The G.A.-CAD package from DARcorporation can cut in half the design/development time of a general aviation aircraft.

ceptual design process of aircraft, giving aircraft builders information they needed to forecast the aircraft's performance, cost, and noise it would generate. Working with airframe and engine manufacturers, Ames formulated ACSYNT to inspect, modify, and integrate the engineering analysis process.

In 1987, Ames and the Virginia Polytechnic Institute CAD Laboratory in Blacksburg, VA, began designing and coding a CAD system for ACSYNT, and in 1990, Ames formed an alliance of industry-government-university participants to improve and foster R&D for the software. Called the ACSYNT Institute, it enabled NASA and Virginia Tech to develop and improve computer-aided aircraft design.

As a result, ACSYNT became a predominant software for aircraft design, providing a 3D CAD environment combined with analysis capabilities. From 1987 to 1995 the R&D conducted helped shape a market for commercialization, and spawned a new company, Phoenix Integration of Blacksburg, VA, which was granted an exclusive license for ACSYNT.

The software enables users to quickly model an aircraft concept in the CAD interface, and analyze it using a suite of multidisciplinary modules representing aerodynamic, propulsion, and mission performance parameters. ACSYNT has been applied successfully to the design of subsonic transports and supersonic fighters.

By way of a Small Business Innovation Research (SBIR) contract from NASA's Langley Research Center, DARcorporation of Lawrence, KS, developed the General Aviation Computer-Aided Design (G.A.-CAD) software for small, general aviation manufacturers. The affordable package enables users to quickly develop an aircraft design, with parameters such as weight, performance, geometry, aerodynamics, thrust/power, stability and control, dynamics, loads, structures, and cost.

The Windows-compatible software can reduce design and development time by 50%, replacing tedious hand calculations. It enables the user to analyze an existing design, make changes to one part of the aircraft, and determine the modification's effect on other aspects of the design.

To Contact Profiled Companies, Call:

Breault Research Organization	520-721-0500
Coryphaeus Software	408-395-4537
DARcorporation	913-832-0434
MacNeal-Schwendler Corp.	213-258-9111
Phoenix Integration	540-231-7215
Transom Technologies	313-761-6001
University of Pennsylvania, Center for Technology Transfer	215-898-9585
ViGYAN	757-865-1400

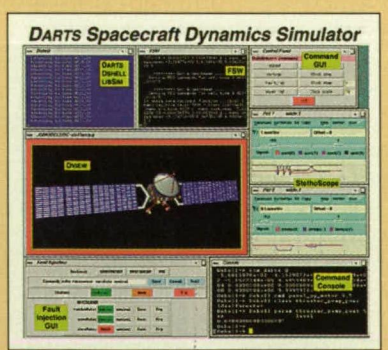
Next Month:

NASA Technologies Used in Communications

Looking Ahead ...

• A computer network tool developed by NASA Ames for airplane manufacturers and government will provide faster access to information to help shorten aircraft design and test processes by about 25%. Called Darwin, the program could revolutionize the way aircraft are designed by using wind tunnels linked with computers that send nearly instant test results via a network to geographically separate labs and companies. Darwin funnels the wind tunnel data into a server computer, and sends knowledge back to the researcher within 30 seconds to five minutes. It is similar to the Internet, but does not allow public access.

• NASA's 1997 Software of the Year not only was used by Jet Propulsion Laboratory (JPL) to keep the Mars Pathfinder on course, but also may be used in research and development of new drugs, catalysts, and polymers. Dynamics Algorithms for Real-Time Simulations (DARTS) software — developed at JPL by Drs. Abhinandan Jain, Guillermo Rodriguez, and Guy K. Man — has saved over $10 million on NASA missions such as Pathfinder, Galileo, and Cassini. The high-fidelity, flexible multibody dynamics simulator is used for design, integration, and testing of spacecraft flight software. DARTS is based on Spatial Operator Algebra (SOA), a mathematical approach for modeling the dynamic behavior of complex, articulated collections of bodies interacting with each other in free space or in contact with the environment.



DARTS software helped keep Mars Pathfinder on course; it also has potential in the research and development of new drugs, catalysts, and polymers.

• Astronauts wearing bulky spacesuits will be working with robotics systems outside the space shuttle to assemble components of the International Space Station. But it's virtually impossible for a free-floating astronaut to perform such work. To accomplish the tasks of driving bolts, turning levers, and plugging connectors, the astronauts need to anchor their feet in positions that will let them see, touch, and manipulate the components. To simulate these tasks previously, NASA used the Neutral Buoyancy simulator, an underwater test facility at Marshall Space Flight Center. But the tests are costly and lengthy, so NASA chose Transom Technologies' Transom Jack human behavior simulation environment (see "See Jack Run" above) to locate and test foot restraints for each task, and then determine if things could be reached by an astronaut in a particular position.

The SHOT That Was Heard Around The World

GageScope for Windows

Oscilloscope Software

- Windows 95 Interface
- Deep Memory
- Multi-Channel
- High Resolution
- High Speed
- Run it in Our PC or Yours

16 Bit, 10 MHz Scope Module

12 Bit 100 MHz Scope Module

500 MHz Scope Module

CALL 1-800-567-GAGE 4243

Ask for extension 3406

GaGe

GAGE APPLIED SCIENCES INC.

1233 Shelburne Road, Suite 400
South Burlington, VT 05403

Tel: 800-567-GAGE Fax: 800-780-8411 e-mail: prodinfo@gage-applied.com web site: http://www.gage-applied.com

From outside the United States contact, Gage Applied Sciences Inc., 2000, 32nd Avenue Lachine, Montreal, QC, Canada H8T 3H7 Tel: (514) 633-7447 Fax: (514) 633-0770

HP Technical Computing

NO BOUNDARIES

UNIX is a registered trademark in the U.S. and other countries, licensed

Andy Saunders of Benetton Formula 1 on an HP workstation. What's your vision?

You have your ideas for developing breakthrough products. But in today's highly competitive and chaotic environment, do you have the tools to realize your vision?

Benetton has what's needed for their ideas. Between every Formula 1 racing season, Benetton engineers design, construct and test an entirely new racing machine. Aerodynamics. Stress analysis. Kinematics. Thanks to HP technical computing systems, this all happens in under five months. Plus, during the race there's real-time analysis and correction via telemetry between the pit crew and the driver. HP provides the tools, solutions and expertise to give Benetton's design, manufacturing and race teams easy access to data across UNIX and Windows NT. So they, in turn, have the powerful graphics capabilities to make their vision a reality, or, in this case, a 210-mph blur.

See what HP can do for your 210-mph blur. Call for your FREE interactive CD:Powering Your Product Development. This easy-to-use program has details on the best processors, the fastest graphics, the richest set of cross-platform collaboration tools and unparalleled worldwide support. Sample the new standard for large model rendering. All from HP. To order the CD visit the HP Web site at www.hp.com/go/mdatools. And get powered up to set new records for fast, cost-effective vision development.

HEWLETT® PACKARD

exclusively through X/Open Company Ltd. Windows is a U.S. registered trademark of Microsoft Corp. ©1997 Hewlett-Packard Company PPG458 59654967E

System Speeds Shuttle Tile Replacement

FaroArm® articulating measurement arm
FARO Technologies
Lake Mary, FL
407-333-9911
Fax: 407-333-4181
www.faro.com

When the space shuttle orbiter reenters Earth's atmosphere, friction heats the leading edges and underside of the vehicle to more than 2,000°F. Unprotected, the skin and airframe of the orbiter would melt. Silica tiles are used to protect it from such heat, but the tiles are brittle, and are occasionally damaged in flight from heat erosion and impacts from meteorites and bird strikes. The 6" square tiles are up to 4" thick, and because of their position on the orbiter, each tile shape is unique. A number of tiles must be replaced after each flight — an intensive process since each tile must be custom made.

United Space Alliance (USA) of Cape Canaveral, FL, refurbishes the tiles after each flight. Until recently, they replaced some of the tiles by hand-crafting a new one to fit into the slot where the old one was removed. This process took up to four days to fabricate a single tile. Now, USA uses the FaroArm® articulating measurement arm to reverse engineer the cavity where a worn tile was removed. Using the data, they form a computerized model of the new tile to be made.

The counterbalanced arm has seven degrees of freedom and measures the 3D shape of any solid surface — or cavity, as in the case of the shuttle tiles. The arm can follow complex curves that cannot be measured by other devices. At each arm "joint," rotational transducers report the X-Y-Z location and I-J-K orientation of the probe stylus located at the end of the arm. To take a measurement, the operator touches the part at the desired location with the stylus and presses a button on the handle.

The arm is connected to a computer supporting AnthroCAM® software, a 3D CAD-based measurement, reverse engineering, and analysis software program developed by FARO for use with the arm. Points captured by the arm are visible on the computer as measurements are taken. A CAD file of the tile profile is transferred to a manufacturing area and entered into a CATIA computer, where it serves as an electronic pattern for cutting the new tile. And once the shape of a tile is established, it is saved as a CAD file, and does not have to be measured again.

The arm probe measures every irregularity in the tile cavity, including screw and rivet heads in the body of the vehicle. The arm can measure objects to a dimensional tolerance of ±0.003 inches.

Measurements, however, must be precise — the outer tile surface must conform to the surface around it, within a tolerance range of 0.030 inch. "If we don't get a smooth transition between the tiles, particularly on the leading edges of the orbiter, the air flow can change from laminar to turbulent sooner than we want it to," said Mike McCarley, USA airframe engineer.

According to McCarley, USA also uses the arm system to check mechanical features of the orbiter. "At this point, we are using the arm to troubleshoot mechanisms that we've never before had the means to test."

For More Information Circle No. 755

Instruments Look For Water on Moon

Neutron, gamma-ray, and alpha particle spectrometers
Los Alamos National Laboratory
Los Alamos, NM
505-667-3839

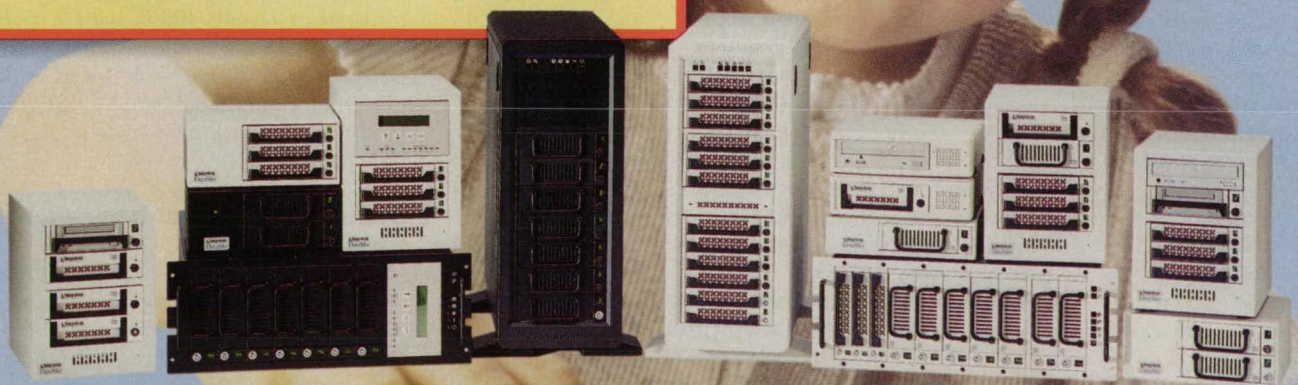
Three Los Alamos instruments on the recently launched Lunar Prospector will look for water, map the location of valuable elements, and gather data on events that release gases from below the surface of the moon. "If we can find sufficient water, it's going to be a land rush like the Oklahoma Sooners," said Bill Feldman, project leader for the Los Alamos instrument package. "Water is the key resource that will support life as well as travel from the moon to the planets. Besides sustaining life for moon colonies, hydrogen from the ice can be extracted for rocket fuel," Feldman explained.

The neutron spectrometer detects and distinguishes neutrons of different energies, and should find even faint traces of any ice that is within three feet of the lunar surface. The gamma ray spectrometer experiment will provide global maps of the major rock-forming elements on the lunar surface. The instrument records the spectrum of gamma rays and neutrons emitted by elements in the moon's crust. The map of certain elements will provide clues to lunar evolution, and will tell future lunar miners where to look for aluminum, iron, uranium, and titanium.

The alpha particle spectrometer will give scientists information on the moon's seismic activity. Lunar magma cooled just beneath the outer crust contains uranium, and as uranium-238 decays, it produces radon. If moonquakes vent radon to the surface, the spectrometer will record the alpha particle signatures of radon's radioactive decay.

For More Information Circle No. 756

WITH KINGSTON, CONFIGURING STORAGE IS AS EASY AS CHILD'S PLAY



YOUR IMAGINATION may be your only limitation when configuring storage solutions using Kingston® enclosures. Combine Data Silo® chassis with modular Data Express® removable drive trays and create your own custom design.

- Feature-packed while meeting strict specifications
- Reliable and ruggedly designed
- Ready to support most popular drive types
- RAID compatible
- Platform-independent
- Shipped with all mounting hardware
- Comprehensive installation guides
- Protected by a 7-year warranty
- Nationally distributed and easy to locate
- Typically shipped ARO next day
- Tested in collaboration with major device mfgrs.

www.kingston.com/storage

Call us today at (800) 259-9370 to find out how Kingston's easy to integrate storage products can bring back your childhood memories.

Kingston® TECHNOLOGY
STORAGE PRODUCTS DIVISION

Kingston Technology Company, 17580 Newhope Street, Fountain Valley, CA 92708, USA (714) 438-1850, Fax (714) 438-1847. © 1997 Kingston Technology Company. All rights reserved. All other trademarks and registered trademarks are the property of their respective owners.

For More Information Circle No. 525

Commercialization Opportunities

Rechargeable Microbatteries With Li Anodes Formed In Situ

These microbatteries would be manufactured in the discharged condition, and lithium anodes would be formed in situ during subsequent charging. This approach improves safety and manufacturability over other state-of-the-art batteries.
(See page 46.)

Optical Horizontal-Displacement Sensors for Crane Payloads

Sensors, using mostly commercial optical and electronic components, are being developed for measuring horizontal displacements of payloads suspended from cranes. This development eliminates the need for running wires along the crane cables. Tests have shown payload positioning accuracy of better than 0.25 in. (6.35 mm) at a distance of 30 ft (9.14 m).
(See page 52.)

Sight-to-Touch Translator

This conceptual electronic apparatus would use the tactile principle of Braille to represent the shapes of nearby objects and thus help the blind wearer avoid obstacles. Under some circumstances, the translator may serve as an electronic alternative to a guide dog.
(See page 56.)

Improving Distributions of Flux in Solar Thermal Receivers

A thermally conductive, thermally emissive radiant shield is used to diffuse the hot spots and thus prolong the life of thermal receivers.
(See page 58.)

Convex-Grating Spectrometer With Two Spherical Mirrors

An improved all-reflecting imaging spectrometer features a wide field of view and a compact design that is 1/3 the size of conventional spectrometers with similar capabilities. Fabrication is relatively easy and inexpensive in comparison with similar instruments.
(See page 63.)

Coating SiC Fiber Tows With Polymer/Silicon Slurries

An apparatus and process were developed for continuous coating and infiltration of SiC fibers with a polymer/silicon slurry. The resulting composites are candidates for use in structural components in some high-temperature applications.
(See page 68.)

Vertical Centrifugal Investment-Casting Machine

An improved machine design increases the strength of investment castings. The machine spins a radially symmetric shell about its axis in a vertical orientation and establishes centrifugal forces that drive the molten metal even into the most obscure crevices of the shell.
(See page 72.)

Behold the future in data recording/reproduction — Metrum-Datatape Inc.

Metrum-Datatape is the leader in recording, reproducing and storage products and systems. The company specializes in the research, development and manufacture of high-performance recording technologies for data acquisition and storage applications.

With a combined heritage of over 100 years pioneering the development of tape recorder/reproducers, Metrum-Datatape has kept pace with its customers' most demanding technical requirements with practical and reliable products and systems.

For more information on Metrum-Datatape's storage system solutions contact Metrum-Datatape Inc. at:
4800 East Dry Creek Road . Littleton, CO 80122-3700
Phone (303) 773-4700; Fax (303) 773-4909
Email info@metrum-datatape.com
www.metrum-datatape.com

METRUM-DATATAPE

Many are sold on our data acquisition system after seeing only one piece of data.

©1997 Hewlett-Packard Co. TMEMD613/NASA

Whether you need a data logger or an automated test solution, the HP 34970A offers you uncompromised functionality and performance. And the features you need to get the job done. Like built-in HP-IB and RS-232 interfaces. A standard three-year warranty. And a price tag that fits within your budget.

PERFORMANCE

- 6 ½ digits resolution (22 bits)
- Built-in signal conditioning measures thermocouples, RTDs, & Thermistors; ac/dc Volts & Current; Resistance; Frequency & Period
- Scanning up to 250 channels per second
- Non-volatile 50,000 reading storage with timestamp

THREE-SLOT FLEXIBILITY

- Multiplexing and Actuation
- Digital I/O, Analog output, Event counting
- RF switching up to 2 GHz
- 4 x 8 Matrix switching

WINDOWS® SOFTWARE

- HP BenchLink Data Logger application included
- HP VEE and LabVIEW® drivers available

"I'll tell you more about how the HP 34970A can meet all your data acquisition needs—for an unbelievably low price. Just give me a call at ***HP DIRECT, 1-800-452-4844** Ext. 5263.***"

Check out our on-line HP Basic Instruments (BI) Catalog at http://www.hp.com/info/bidaq1
Faxback: 1-800-800-5281, Document 12254.

HEWLETT® PACKARD

**U.S. list price*
***In Canada, call 1-800-387-3154, program number TMA125.*

Windows® is a U.S. registered trademark of Microsoft Corporation.
LabVIEW® is a U.S. registered trademark of National Instruments Corporation.

For More Information Circle No. 521

Software for Assessing Effects of Designs on Operations

Assessments can be performed quickly with powerful software tools and an extensive data base.

John F. Kennedy Space Center, Florida

The Operations Impact Assessor (OIA) computer program facilitates rapid assessment of the effects of designs of spacecraft on spacecraft-processing operations at a launch site. OIA is a user-friendly, object-oriented, artificial-intelligence application program that features model-based reasoning and scheduling of discrete events.

The OIA enables the user to quickly develop a semantic model of a conceptual launch vehicle and its processing at a launch site to assess the effects of various elements of the design of the vehicle on the processing operations. The assessments can include evaluations of operability and processing requirements pertaining to such things as ground support equipment, utilization of facilities, labor, and processing schedules.

The use of the OIA proceeds in three stages: construction of a model of the launch vehicle, development of a model of process flow, and generation of an operational time line. The OIA consists of three major components — intelligent assistants, the knowledge base, and utilities. The combination of these components provides an integrated operations-modeling environment. The OIA exploits an object-oriented frame system to store a model of the vehicle, resources, attributes, and schedules. Following a model-view-controller approach, the software can provide alternate views into the same knowledge base.

The intelligent-assistants component of the OIA includes two intelligent assistants to aid in construction and evaluation of semantic models. The Vehicle Definition Assistant (VDA) helps the user in quickly constructing a model of a conceptual launch vehicle by defining its components, subsystems, systems, and hierarchical relationships among them. The Operations Definition Assistant (ODA) helps the user define and assess launch-vehicle-processing flow, time lines, and requirements.

The knowledge base contains an extensive, expandable collection of data on launch vehicles and components thereof. It also contains data on processing and resources pertinent to launch vehicles and their components. The knowledge base is contained in a common template library and individual project libraries. The user gains access to the vehicle data via the VDA and to the processing and resource data via the ODA.

The utilities component of the OIA includes three major software utilities that support the intelligent assistants. One utility is the Assessment Tool, which prepares a schedule of the vehicle-processing flow for comparison with other vehicle flows. Another utility is the Reporting Tool, which generates time lines, resource histograms, and other reports in different formats to identify and display the effects on schedules and resources. The Reporting Tool is also used to format and transmit the output of the Assessment Tool for printing or for use in other computer programs. The third utility is the Model Management utility, which provides a link between the intelligent assistants and the internal sources of data. While functioning automatically in the background, this utility also enables the storage and retrieval of models and provides access to both internal and external sources of data.

This work was done by John J. Cwiklinski, Robert B. Sieck, Jr., and Roy C. Tharpe, Jr., of McDonnell Douglas Corp. for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 129*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11836.

Program for Design Analysis of Cache Memory

John F. Kennedy Space Center, Florida

CACHESIM is a C-language computer program that simulates (1) cache-memory options associated with a computer hardware design concept and (2) related properties that can be expected to affect the overall performance of the computer, before the computer is constructed. Heretofore, the performance effects of cache-memory options were investigated through hardware monitoring. *CACHESIM* provides for selection of options that include hardware organization, cache size, line size, replacement policy, write-hit policy, write-miss policy, fetch policy, simulated processor speed, processor instruction-execution clock cycles, and cache-miss clock-cycle penalty. For a given combination of options, the output of *CACHESIM* includes appropriate hit and miss rates, central-processing-unit time, and the number of memory stall cycles incurred. This information is useful in determining the overall effectiveness and performance of the cache design.

This work was done by José J. Amador of **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 172*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

KSC-11924

And then there was...

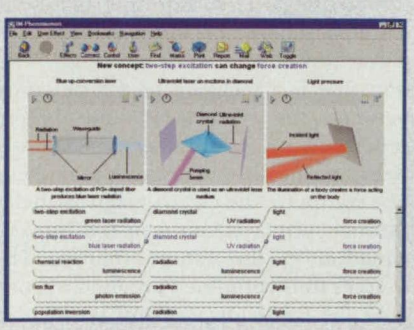
IM-Phenomenon™

PROFESSIONAL EDITION

Computer-Aided Innovation Software

Creates innovative engineering solutions in seconds!

For the first time in the history of engineering, software invents new concepts. Based on your selected criteria, IM-Phenomenon searches its comprehensive engineering knowledge-base, and generates concepts that lead to novel engineering solutions.



IM-Phenomenon takes advantage of hundreds of years of scientific research, solving problems across many fields of engineering. IM-Phenomenon helps you in the conceptual stage of design with an automatic and in-depth system of knowledge creation and knowledge management.

For more information or to order call:

1-800-595-5500

Or visit us on the Web at:

www.invention-machine.com

See us at NDES '98, Booth #6834

Invention Machine®

Software That Invents™

The ideal enhancement to TechOptimizer™

FIVE-STAR Product of the Year

designfax

Product Of The Month

NASA TECH BRIEFS

ENGINEERING SOLUTIONS FOR DESIGN & MANUFACTURING

For More Information Circle No. 524

In today's world of engineering, time is money,

Trademarks and registered trademarks of Invention Machine Corporation include Invention Machine, Software That Invents, IM-Phenomenon, and TechOptimizer.

Program for Microanalysis of Composite Structures

Phenomena that can be analyzed include elastostatics, heat transfer, thermoelasticity, elastoplasticity, and creep.

Lewis Research Center, Cleveland, Ohio

Version 3.0 of the Boundary Element Solutions Technology Composite Modeling System (BESTCMS 3.0) is an advanced engineering software system for the microanalysis of fiber composite structures. BESTCMS is based on the BEST3D boundary-element program (COSMIC program LEW-15351). BESTCMS affords capabilities for analyses of elastostatic behavior, steady-state and transient heat transfer, steady-state and transient concurrent thermoelasticity, elastoplasticity, and creep.

In BESTCMS, the fibers can be assumed to be perfectly bonded to the matrix in a composite material; alternatively, in static or steady-state analysis, one can assume that there are spring connections, thermal resistances, and/or frictional sliding between the fibers and the matrix.

BESTCMS is written in FORTRAN 77 to be machine-independent across UNIX platforms. BESTCMS has been successfully implemented on the following computers and operating systems: SUN 4 IPC running Solaris 2.4 (SunOS 5.4), SGI IRIS Indigo2 running IRIX 6.2, HP 9000/720 running HP-UX A.09.01, and IBM RS/6000 running AIX 4. For efficient execution, BESTCMS requires a minimum of 8MB of random-access memory; for efficient execution in cases of practical three-dimensional problems, 300MB of temporary disk storage capacity is recommended. The standard distribution medium for BESTCMS is one 4-mm DAT cartridge in UNIX tar format. Alternate distribution media are available upon request. BESTCMS 3.0 was released to COSMIC in 1997.

This work was done by D. A. Hopkins of **Lewis Research Center** *and P.K. Banerjee and D.P. Henry of the State University of New York at Buffalo. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 152*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

LEW-16472

Genetic Algorithms Help Design Dielectric Grating Filters

Genetic algorithms can reveal previously unknown solutions to design problems.

NASA's Jet Propulsion Laboratory, Pasadena, California

A computational method for designing all-dielectric grating electromagnetic filters involves a combination of (1) numerical simulation of filter performance via integral-equation solution of Maxwell's equations and (2) genetic algorithms to find acceptable combinations of filter-design parameters. The method can be used to design filters of various types (e.g., band-pass, stop-band, or dichroic) for wavelengths from ultraviolet to microwave. One important potential application for the method might lie in the design of all-dielectric microwave dichroic filters for radomes; at present, all-dielectric versions are unknown and the filters are made of metals.

A typical all-dielectric grating filter can be a single- or multiple-layer plate with a periodic inhomogeneity in the dielectric material and/or a periodic variation in thickness (see figure). For the purpose of mathematical modeling, it is assumed that the filter lies in the x–y plane, the periodicity is in the x direction, and the filter is of infinite extent in the y direction and has a thickness t in the z direction. The material in each unit cell or subdivision of a unit cell is characterized by a complex permittivity and possibly by a complex permeability and/or a small conductivity.

The design problem is to find the permittivity, permeability, conductivity, and/or geometric parameters of the periodic structure (hereafter called "material parameters" for short) to obtain an acceptably close approximation to the desired reflectivity or transmissivity as a function of illumination angle and wavelength. This problem shares some of the formalism of the problem of identifying and locating dielectric objects, given the electromagnetic fields scattered from the object; both are nonlinear inverse source problems that involve the same integral-equation solutions of Maxwell's equations: The electromagnetic sources (electric and magnetic current densities) in a given material volume are related to outside electromagnetic fields by a linear integral equation derived from Maxwell's equations. The sources are related to the fields inside the volume by a constitutive equation that includes the material properties. Then the relationship linking the fields outside the source region to those inside is nonlinear in the material properties.

In this method, the nonlinear inverse problem is solved in two linear steps. For this purpose, the electromagnetic sources in the computational material volume are introduced as unknowns in addition to the material unknowns, making it possible to solve for source-volume fields and material parameters consistent with Maxwell's equations. Solutions are obtained iteratively by decoupling the two steps. First, one inverts for the material parameters only as part of a process of minimization of a cost function that is a measure of the deviation between the synthesized and desired reflectivity or transmissivity response. Next, given the material parameters, one computes the electromagnetic fields through direct solution of the integral equation in the source volume. The sources thus computed are used to compute the far fields and thus the synthesized transmissivity or reflectivity response of the filter.

The inversion to compute the material parameters is performed by use of a genetic-algorithm software package, called "PGAPACK," that incorporates capabilities for parallel processing. Genetic algorithms offer advantages over gradient-based and other local search methods for this and other electromagnetic-design problems, the solution spaces of which contain many extrema of cost functions. The ability of genetic algorithms to search parameter spaces globally not only makes it possible to avoid the common pitfall of converging on local (but not global) minima, but also holds promise for finding previously unknown solutions.

Maxwell® EM by Ansoft
The Choice for Electromagnetics

TRANSFORMERS

SENSORS

ELECTRICAL MACHINERY

MAGNETIC SUSPENSION SYSTEMS

MEMS

NON-DESTRUCTIVE TESTING

TRANSISTORS

TRANSDUCERS

ELECTRONIC CONTROLS

RELAYS

ABS BRAKING SYSTEMS

HIGH FORCE ACTUATORS

POWER CONVERTERS

POWER DISTRIBUTION

MOTORS

CIRCUIT BREAKERS

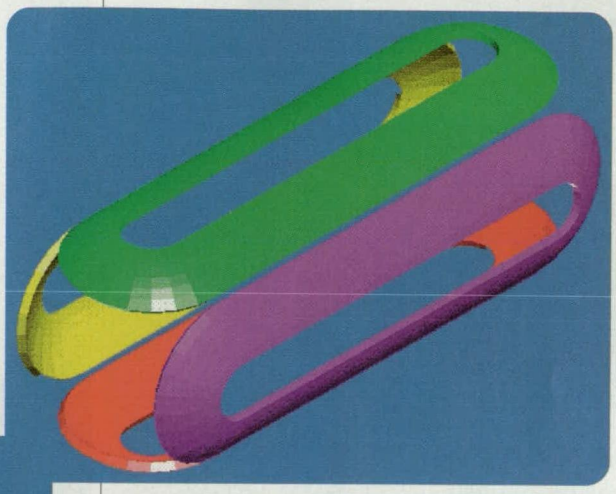
VOLTAGE SWITCHGEAR

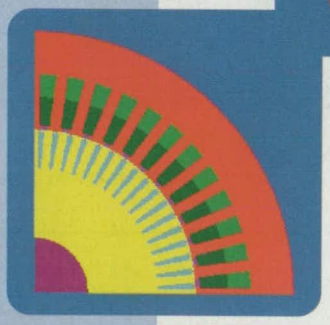
MRI

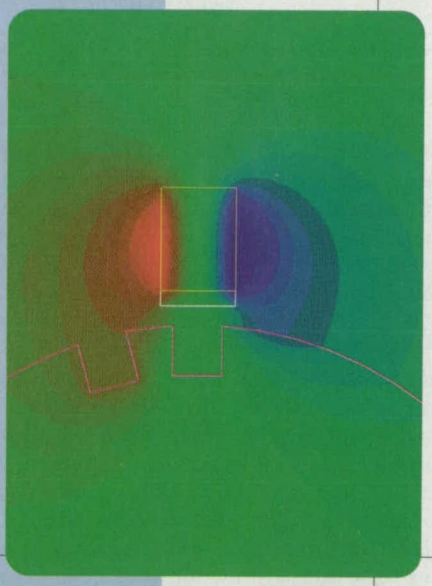
MAGNETIC RECORDING

SOLENOIDS

PERMANENT MAGNETS







INDUCTANCE & CAPACITANCE

ELECTROPHORESIS

SHIELDING

INSULATION

FLAW DETECTION

FORCES & TORQUES

FLUX LINKAGE

BACK EMF

VELOCITY

POWER LOSSES

SATURATION

SKIN & PROXIMITY EFFECTS

RESISTANCE

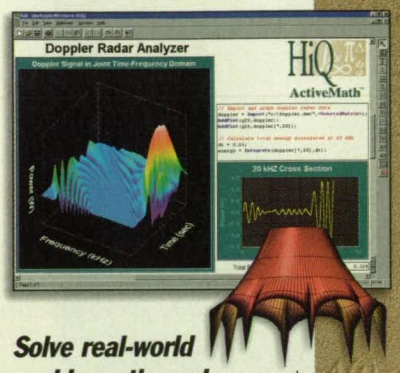
CURRENT DISTRIBUTION

ANSOFT

Ansoft Corporation • phone 412.261.3200 • fax 412.471.9427 • email info@ansoft.com • www.ansoft.com

For More Information Circle No. 470

Get Integrated! With NEW HiQ™ 3.1



Solve real-world problems through interactive analysis, data visualization, and report generation in a single, intuitive HiQ environment.

New 3.1 Version for Windows NT/95

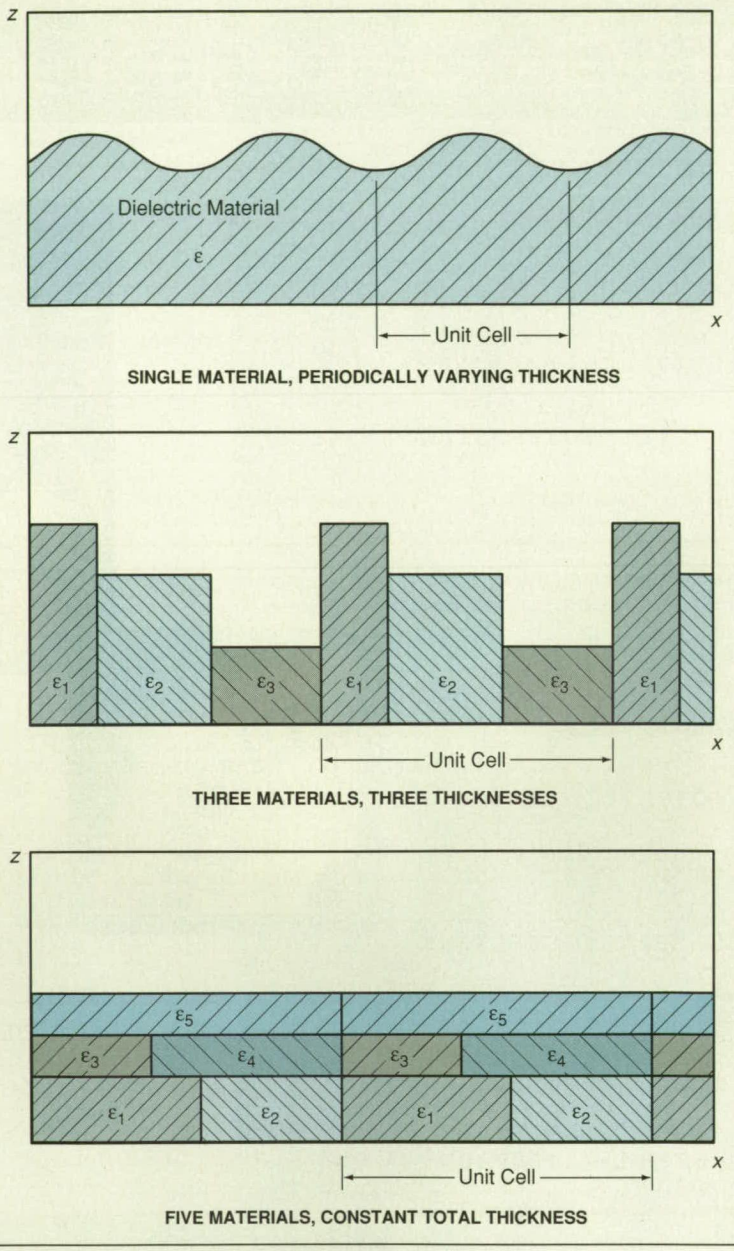
- Powerful math and data analysis functions
- OpenGL 3D data visualization
- Interactive technical report generation
- Problem Solver notebooks
- OLE connectivity with Microsoft Office
- Intelligent data import/export wizards
- ActiveX technology
- HiQ-Script™ programming language for analysis
- Add-on analysis toolkits
- Direct link to LabVIEW® for data acquisition

For your FREE HiQ evaluation software kit, call
(800) 661-6063
(U.S. and Canada)

NATIONAL INSTRUMENTS™
The Software is the Instrument™

U.S. Corporate Headquarters
Tel: (512) 794-0100 • Fax: (512) 794-8411
info@natinst.com • www.natinst.com
Worldwide network of direct offices and distributors.

© Copyright 1997 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies.

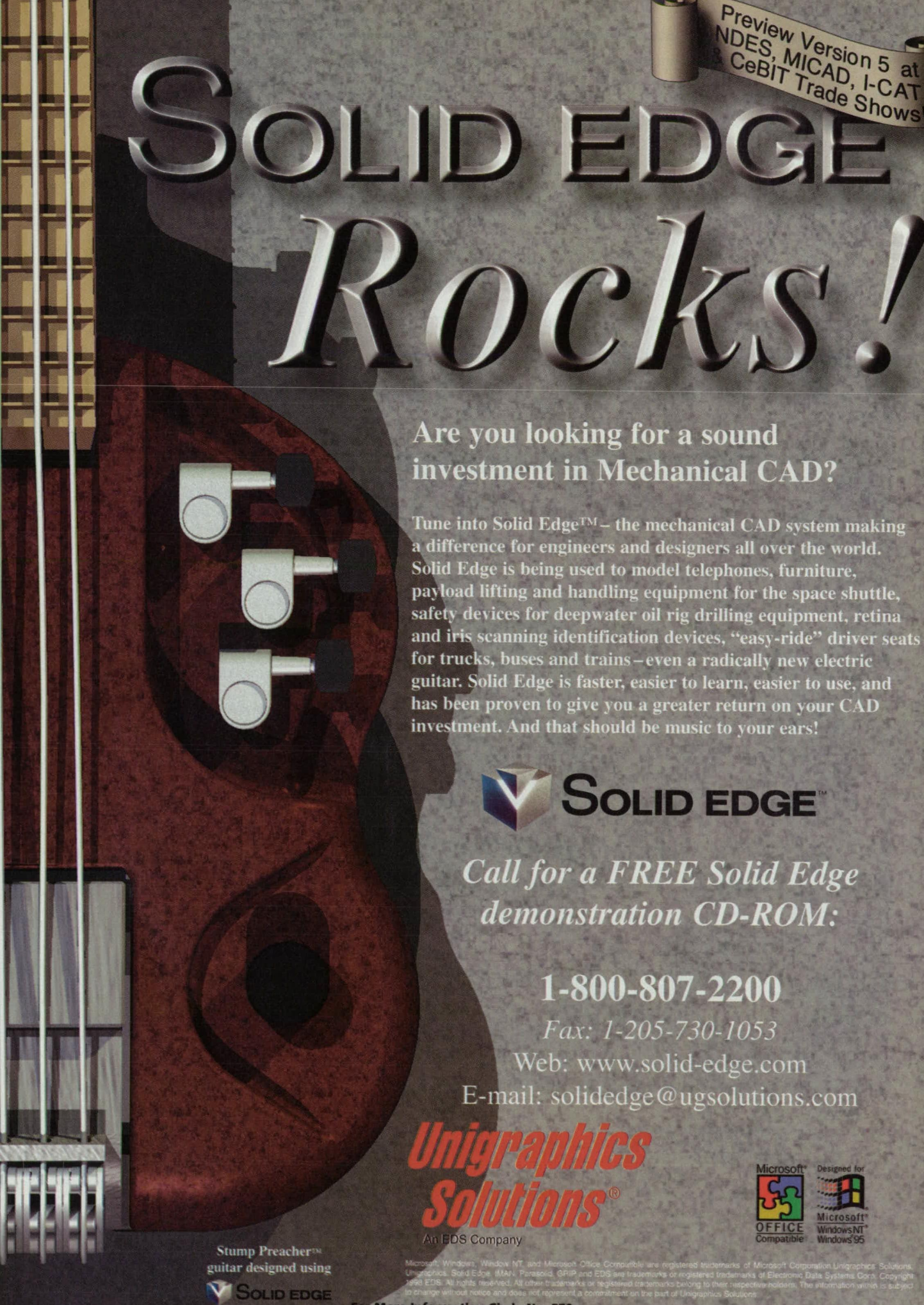


Dielectric Grating Filters can have any of a large variety of periodic configurations, of which only a few examples are shown here. In each case, ε (with or without a subscript) denotes the complex permittivity of the material.

The possibility of finding previously unknown solutions is especially important in that it could enable one to design relatively simple or otherwise preferable filters and to investigate trends in material parameters.

The most expensive part of the computational cycle is solving for the electromagnetic fields. The computational burden is reduced by use of a matrix-vector formulation in which a set of frequency-dependent matrices need be filled only once. In addition, the number of frequencies for which the design equations are solved is reduced by using a transfer-function parameter-estimation technique in which the desired filter response is expressed as a quotient of frequency-dependent polynomials. The computation time is reduced further by taking full advantage of parallel-processing capabilities of PGAPACK on a Cray T3D computer. The parallelization scheme involves a simple master/slave configuration, with the expensive evaluation cycle distributed among the processors.

This work was done by Cinzia Zuffada and Tom Cwik of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 155*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-20158


Preview Version 5 at
NDES, MICAD, I-CAT
& CeBIT Trade Shows!
SOLID EDGE
Rocks!
Are you looking for a sound investment in Mechanical CAD?
Tune into Solid Edge™ – the mechanical CAD system making a difference for engineers and designers all over the world. Solid Edge is being used to model telephones, furniture, payload lifting and handling equipment for the space shuttle, safety devices for deepwater oil rig drilling equipment, retina and iris scanning identification devices, "easy-ride" driver seats for trucks, buses and trains – even a radically new electric guitar. Solid Edge is faster, easier to learn, easier to use, and has been proven to give you a greater return on your CAD investment. And that should be music to your ears!
SOLID EDGE™
Call for a FREE Solid Edge demonstration CD-ROM:
1-800-807-2200
Fax: 1-205-730-1053
Web: www.solid-edge.com
E-mail: solidedge@ugsolutions.com
Unigraphics Solutions®
An EDS Company
Microsoft OFFICE Compatible
Designed for Microsoft Windows NT Windows 95
Stump Preacher™ guitar designed using
SOLID EDGE
Microsoft, Windows, Window NT, and Microsoft Office Compatible are registered trademarks of Microsoft Corporation.Unigraphics Solutions, Unigraphics, Solid Edge, IMAN, Parasolid, GRIP and EDS are trademarks or registered trademarks of Electronic Data Systems Corp. Copyright 1996 EDS. All rights reserved. All other trademarks or registered trademarks belong to their respective holders. The information within is subject to change without notice and does not represent a commitment on the part of Unigraphics Solutions.

Software for Tooth-Contact Analysis of Spiral Bevel Gears

Sources of transmission errors are analyzed in order to minimize vibrations.

Lewis Research Center, Cleveland, Ohio

The SBGTAPER computer program implements a method for design and generation of spiral bevel gears that feature tapered teeth with localized bearing contact and a low level of transmission errors. The influence of misalignment on transmission errors and shift of bearing contact were investigated in the development of the method.

The SBGTAPER approach emphasizes detection and avoidance (i) of vibration caused by misalignment and (ii) of an edge contact caused by interference between the working part of the surface of a gear with the fillet surface of the mating gear. The main features of this approach are the following:

1. The localization of the bearing contact is achieved by the mismatch of the generating surfaces. The bearing contact can be provided in the longitudinal direction or in the direction across the surface.
2. The low level of transmission errors is achieved because of application of nonlinear relations between the motions of gears and of gear-head cutters. Such relations can be obtained from application programs for computer numerically controlled (CNC) machine tools. The generation of a pinion is based on linear relations between the motions of the pinion and of the tool used to make the pinion. These relations make it possible to obtain a parabolic function of transmission errors that can absorb almost-linear functions caused by misalignment.

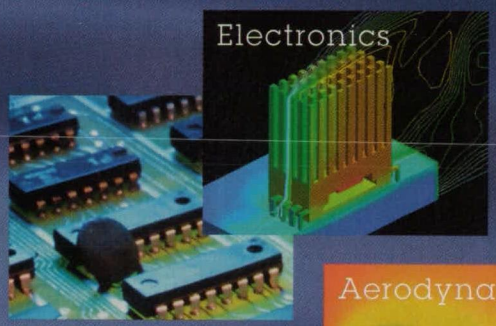
SBGTAPER is written in FORTRAN 77 for IBM-PC-compatible computers. The IMSL libraries and a FORTRAN compiler are required. No executable code is provided because input data are entered directly into the source code. SBGTAPER has been successfully executed on a 486 computer running Windows 95 with Microsoft Fortran Powerstation 4.0. The standard distribution medium for SBGTAPER is one 3.5-in. (8.89-cm) diskette in MS-DOS format. The contents of the diskette have been compressed by use of the PKWARE archiving software tools. SBGTAPER was released to COSMIC in 1997.

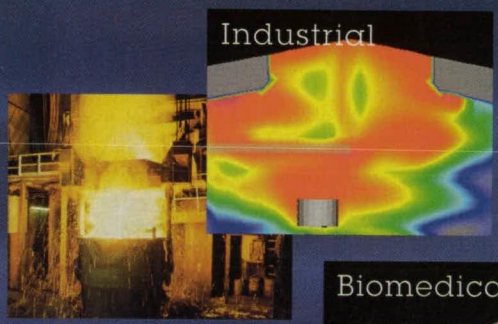
This program was written by F. L. Litvin and A. Wang of the University of Illinois at Chicago and R. F. Handschuh of the Army Research Laboratory for **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 156*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

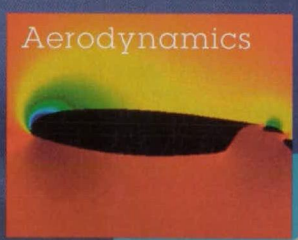
LEW-16493

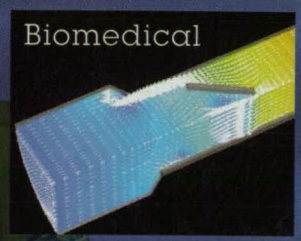
CFD2000®

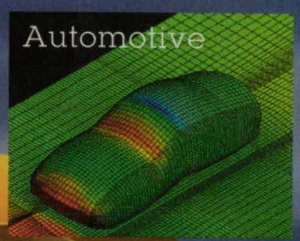
generating real results...











www.adaptive-research.com

sales@adaptive-research.com

Trying to solve real-world fluid flow and heat transfer problems?

The solution...CFD2000. The most powerful and cost-effective CFD/CAD software system available to engineers. Period. With CFD2000, you can analyze and improve your designs without the cost of real-world testing. This means a more cost-effective design cycle. CFD2000 helps you identify design flaws early, resulting in a better product and shorter time-to-market. Adaptive Research is dedicated to building strong relationships with clients and ensuring their success by providing quality software and expert technical support. Adaptive Research has the solution for you...CFD2000.

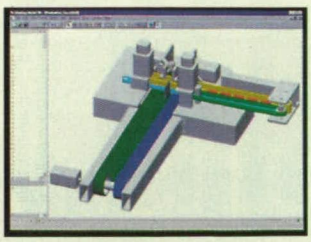
CALL FOR FREE DEMO CD OF CFD2000

adaptive® RESEARCH
a Division of Pacific-Sierra Research Corporation

2901 28th Street, Suite 300
Santa Monica, California 90405
(800) 326-5155

Huntsville, Alabama
(800) 321-2426

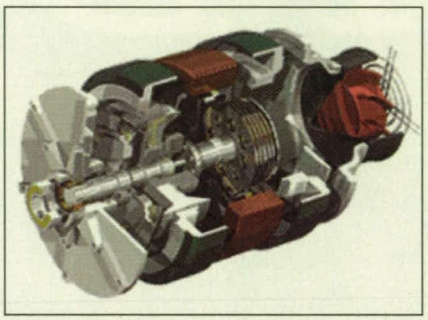
For More Information Circle No. 555



Working Model, San Mateo, CA, has introduced Working Model® 3.0 **mechanical engineering/design/simulation software** that offers associativity with major CAD packages and the ability to export fully functioning models to Web pages for remote design collaboration. It also provides seamless links to finite element analysis (FEA) tools, and enables users to make a CAD design change and update their Working Model immediately when using Mechanical Desktop®, SolidWorks™, or Solid Edge™ CAD software.

Smart Editing technology allows users to create any 3D machine or device, and via a mouse, open and close a door, retract landing gear, or move an engine through a cycle. Interactive input sliders allow simulation of real-time inputs to motors, actuators, drivers, or mass and material properties. Other features include build models containing 100 or more parts or sub-assemblies, and instantaneous assembly modeling.

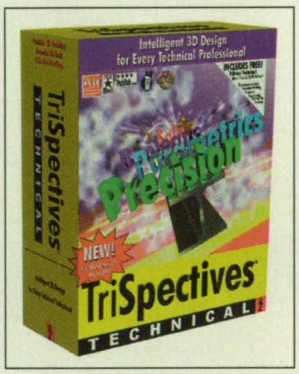
For More Information Circle No. 754



Intergraph Corporation, Huntsville, AL, has released Solid Edge™ version 4 **CAD software** for mechanical assembly, part modeling, and drawing production in the Windows environment. New features include expanded part modeling using helical features, 3D sweep, and advanced blending; animation of underconstrained assemblies; advanced production drawing; and data access via a web-enabled OLE server and smart viewer.

The Microsoft Office 97-compatible program offers enhanced data translation to and from AutoCAD and MicroStation; an enhanced and simplified IGES translator; and integration with Intergraph's Plant Design System (PDS) software. Solid Edge is ISO 9001 certified.

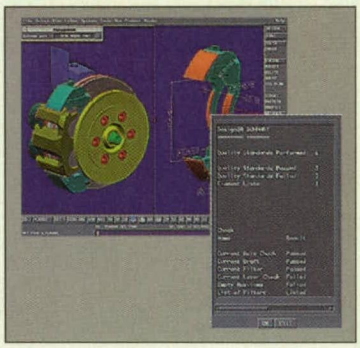
For More Information Circle No. 752



TriSpectives® Technical 2.0 **3D solid modeling software** from 3D/EYE, Atlanta, GA, allows users to create ACIS-based intelligent 3D models from complex 2D cross-sections, and applies advanced rendering techniques, animation effects, and import and export of models in popular 3D CAD file formats. The Windows 95/NT program features IntelliShape™ 3D modeling and improved SmartDimensions™ for positioning and standards-based annotations.

New additions include more than ten drawing tools; more than 10 editing tools; construction geometry; on-screen dimensional feedback; more than 1,000 3D models; and new rendering tools. OLE 2.0 connectivity allows integration with office automation suites such as Microsoft Office. Import/export file translators include IGES, SAT, STEP, and STL.

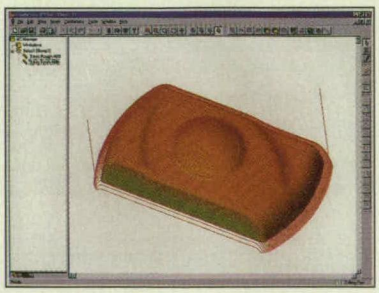
For More Information Circle No. 743



DesignQA **CAD/CAM design problem detection software** from Prescient Technologies, Boston, MA, provides detection, quality assessment, and assistance in correcting problems in CAD/CAM design data. It detects design problems and provides quantitative and qualitative assessments of the problem and overall model quality, enabling the user to evaluate the overall impact of the problem and correct it early in the process.

The software provides three options for each problem encountered: automatic correction; recommendations for corrective actions; and designer override. It comes preconfigured with more than 65 quality standards. Features include automatic integration with Internet/ Intranet and other URL references, and e-mail systems; and direct link to hard-copy printing.

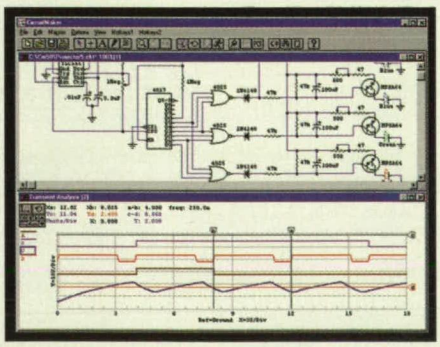
For More Information Circle No. 750



TekSoft, Phoenix, AZ, has released CAMWorks 97 Plus **solid machining software** that operates fully within the SolidWorks environment. Enhancements include three-axis milling capabilities, Automatic Feature Recognition functionality, and additional 2-1/2-axis machining functionality. The software uses SolidWorks geometry to generate toolpaths to ensure that the machined part is same as the modeled part.

Features include automatic tool path regeneration after part changes; and knowledge-based machining where a common database such as Microsoft Access is applied to the machinable features to create cutting operations and tool paths. The machining database includes information on tooling, feeds, and speeds; and automatically defines machinable features such as pockets, bosses, slots, and holes.

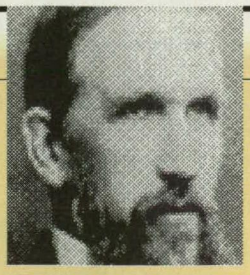
For More Information Circle No. 746



CircuitMaker® Version 5 **circuit design software** from MicroCode Engineering, Orem, UT, is a schematic capture and simulation tool that features mixed-signal simulation of any combination of analog and digital components without manually inserting A/D or D/A translators. Designers can export CircuitMaker schematics as PCB netlists for use in printed circuit board layout products.

The software features a 32-bit SPICE3f5/XSpice-based simulator for analog and mixed-signal circuits, SmartWires™ automatic wire routing, a macro feature for hierarchical devices, and a built-in symbol editor. It operates on Windows 95/NT/3.1x.

For More Information Circle No. 747



ELISHA GRAY,
INVENTOR OF THE TELEPHONE.

POOR ELISHA GRAY.

FILED FOR A PATENT ON HIS TELEPHONE PROTOTYPE JUST THREE HOURS AFTER ALEXANDER GRAHAM BELL FILED FOR HIS.

THERE'S NO AWARD FOR SECOND PLACE.

FINISH FIRST!

IMPROVE PERFORMANCE AND GET YOUR PRODUCT TO MARKET FASTER FOR LESS MONEY WITH HP AND ANSYS.

INTRODUCING THE
HP/ANSYS HARDWARE/SOFTWARE BUNDLE.

ONLY **$45,000.00** U.S. Dollars

A fully optimized engineering solution at an unbeatable price.*

ANSYS/Mechanical™ Software: The most widely used design analysis tool in the world, capable of solving diverse analyses, including linear and nonlinear structural, steady-state and transient thermal, and coupled-field analysis. ANSYS/Mechanical™ is packed full of functionality, with the power to solve just about any structural problem.

*The HP/ANSYS Hardware/Software bundle is available at this price for a limited time only. Advertised price is for specifications listed above. Offer valid in North America only.

HPC200 Technical Workstation Specifications:

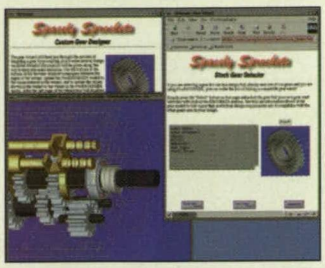
- Base system with 200MHz PA-RISC 8200 CPU
- 512MB High-Density ECC Memory
- 9GB Ultra SCSI Internal Hard Disk Drive
- 12x CD-ROM Internal Disk Drive
- 20" Color Quartz Monitor, 1280 x 1024 resolution
- VISUALIZE-FX2 3D Solid Graphics Accelerator. 24-bit frame buffer with 8 overlay planes.

ANSYS
No Boundaries

HEWLETT PACKARD
Premier Solution Partner

Call toll-free at 1-888-844-6547.

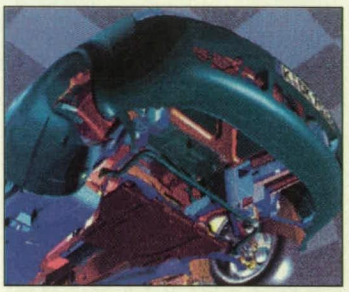
Visit our websites at: www.ansys.com or www.hp.com/go/workstations.



Parametric Technology Corp., Waltham, MA, has announced Release 19.0 of Pro/ENGINEER **CAD software** that includes three new modules for enhanced information management, migration of legacy data, and interaction through a Netscape® browser. The Pro/INTRALINK module is a concurrent development management system that allows users to incorporate information management activities directly into the design process.

Pro/Web.Link is a Netscape plug-in that features a Java applet. It connects to a Pro/ENGINEER session, linking the design engineer to the Web. It allows users to integrate information directly from the Web to modify the 3D CAD model under development in Pro/ENGINEER. Pro/DocMgr provides enhanced management and viewing of non-Pro/ENGINEER documents through Pro/INTRALINK. Documents can be modified and stored within Pro/INTRALINK and automatically converted to a neutral representation for viewing.

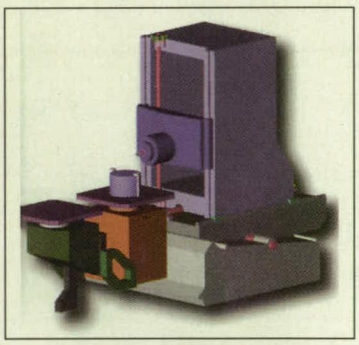
For More Information Circle No. 745



Tecoplan Informatik, Troy, MI, has introduced Virtual Workshop Version 4 digital **mockup software suite** that includes Digital Mockup (DMU), Electronic Mockup (EMU), Virtual Prototyping, and Digital Prototyping. The suite allows engineers to perform digital assembly tests, simulations, visualizations, and data communications, regardless of the CAD system they are using.

The DMU Server can be addressed from applications such as virtual reality, ergonomics calculations, crash simulations, flow simulations, and robotics; and allows all functions to be accessible through the Intranet/Internet. A CAD interface module allows integration of the software with major CAD systems such as CATIA, CADDS, Pro/E, IDEAS, and AutoCAD. Available for Windows NT and UNIX, the software includes ViewVOX and FlyVOX modules that provide visualization and virtual fly-through of assemblies, respectively.

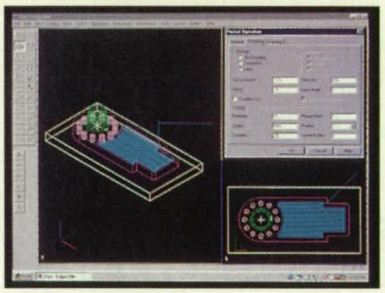
For More Information Circle No. 748



The Virtual Manufacturing Suite solid-model-based NC **machine design/simulation software** from Sirius Systems Corp., San Jose, CA, simulates and reproduces the numerical control (NC) machine and machining process. The software suite includes NC Verify, a solid model verification of the material removal process; Machine Simulator, which animates the NC machine to detect collisions; Virtual Controller post-processor, which emulates CNC machine controllers; and NC Optimizer for analyzing NC toolpaths.

The software runs on Windows 95/NT, Silicon Graphics/IRIX, and IBM/AIX UNIX platforms, and provides advanced error detection, waste elimination, and manufacturing cost reduction. The four modules can be used together or as standalone products.

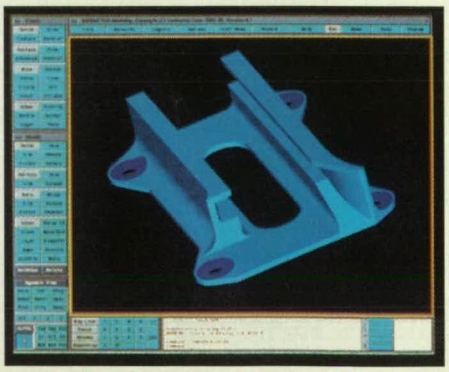
For More Information Circle No. 749



Pathtrace Systems, Ontario, CA, offers EdgeCam 3.0 **CAM software** that supports direct machining of splines and NURBS for Fanuc and Heidenhain control systems. The 32-bit Windows 95/NT program provides operational programming; optimized link moves; automatic cusp height control; and direct loading of par files from Intergraph's Solid Edge CAD software, enabling NC code to be generated straight from the 3D model without translation.

It supports most machines, including rotary and multi-plane milling; 2-1/2- to 3-axis surface milling; 2-, 4-, C-, and Y-axis turning; and 2- to 4-axis wire EDM. The Operational Programming allows automation of repetitive elements by reducing keystrokes and mouseclicks.

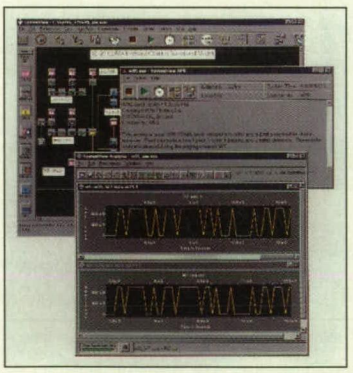
For More Information Circle No. 751



Varimetrix North America, Irvine, CA, has released version 6.1 of Varimetrix (VX) **3D solid modeling software** that includes IGES, DXF, and STL data translators; associative drafting; assembly modeling; and machine tool simulation. Also featured are 3D dynamic rotation of shaded solid models and inquiry functions that allow quick analysis of imported data.

New capabilities include solid draft command; copying geometry from point to point; offset of multiple surfaces at one time; shading and hidden line utilities; and a surface and wireframe option for importing CATIA models.

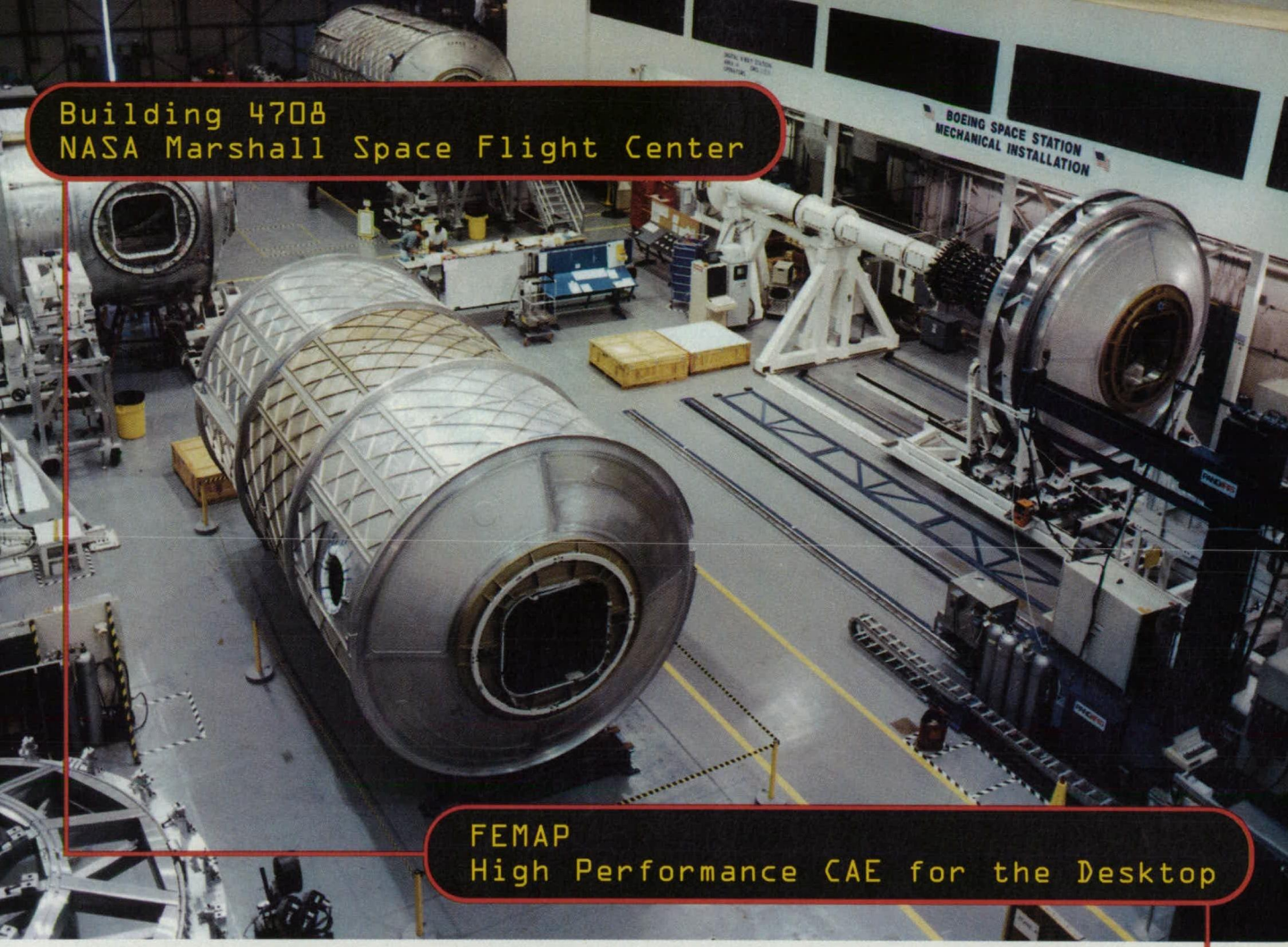
For More Information Circle No. 753



Elanix, Westlake Village, CA, offers v2.0 of SystemView **system design software** for designing, simulating, and testing communications, DSP, signal processing, and RF/analog systems. The 32-bit Windows 95/NT program offers Automatic Program Generation (APG) for accelerating any processing-intensive model; a stream-driven simulation engine; and enhanced model libraries.

New audio signal processing features include support for monaural (one channel) and stereo (2 channels) audio, 8- or 16-bits per audio sample data, and true multi-rate DSP audio processing, including up-sampling and down-sampling. Source and Function models allow users to create custom source and function models by specifying the number of inputs and outputs, and defining their functions.

For More Information Circle No. 744

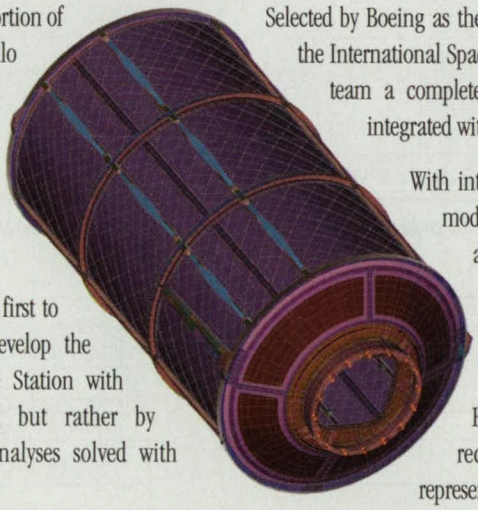


If FEMAP® can handle THIS team's modeling needs, it can handle YOURS.

Each day visitors tour the place where the U.S. portion of the most ambitious space program since the Apollo moon landings is coming to life.

Only a short distance away in Room 229 a team of engineers is looking at the Space Station in another way — through the eyes of FEMAP®.

Engineers in Huntsville were in many ways the first to "see" the Space Station using FEMAP to develop the structural design. They examine the Space Station with FEMAP, not directly with eyes or hands, but rather by interpreting the results of finite element analyses solved with NASTRAN and ABAQUS.



Selected by Boeing as the primary analysis modeling system for the International Space Station, FEMAP affords the Huntsville team a complete engineering solution that is tightly integrated with their Windows desktop environment.

With integrated beam, shell and solid analysis modeling, support for a wide range of solvers and flexible results processing, FEMAP has become the product of choice for professional analysis modeling on the desktop.

For more information or to discuss your requirements with a FEMAP technical representative, call 610-458-3660.

ENTERPRISE SOFTWARE PRODUCTS, INC. • 415 Eagleview Boulevard • Exton, PA 19341 USA • Tel: +1 610 458 3660 • FAX: +1 610 458 3665 • www.femap.com

® FEMAP is a registered trademark of Enterprise Software Products, Inc. All other trademarks are the property of their respective owners. Images courtesy of Boeing Defense and Space Group.

Rechargeable Microbatteries With Li Anodes Formed In Situ

These batteries would offer advantages with respect to safety and manufacturability.

NASA's Jet Propulsion Laboratory, Pasadena, California

Rechargeable, thin-film, lithium-based microbatteries of the proposed type would be manufactured in the discharged condition, and lithium anodes would be formed in situ during subsequent charging. In contrast, state-of-the-art rechargeable, thin-film, lithium-based microbatteries are fabricated in the charged condition, with metallic lithium anodes. As explained below, the proposed batteries would offer advantages of safety and manufacturability over the state-of-the-art batteries.

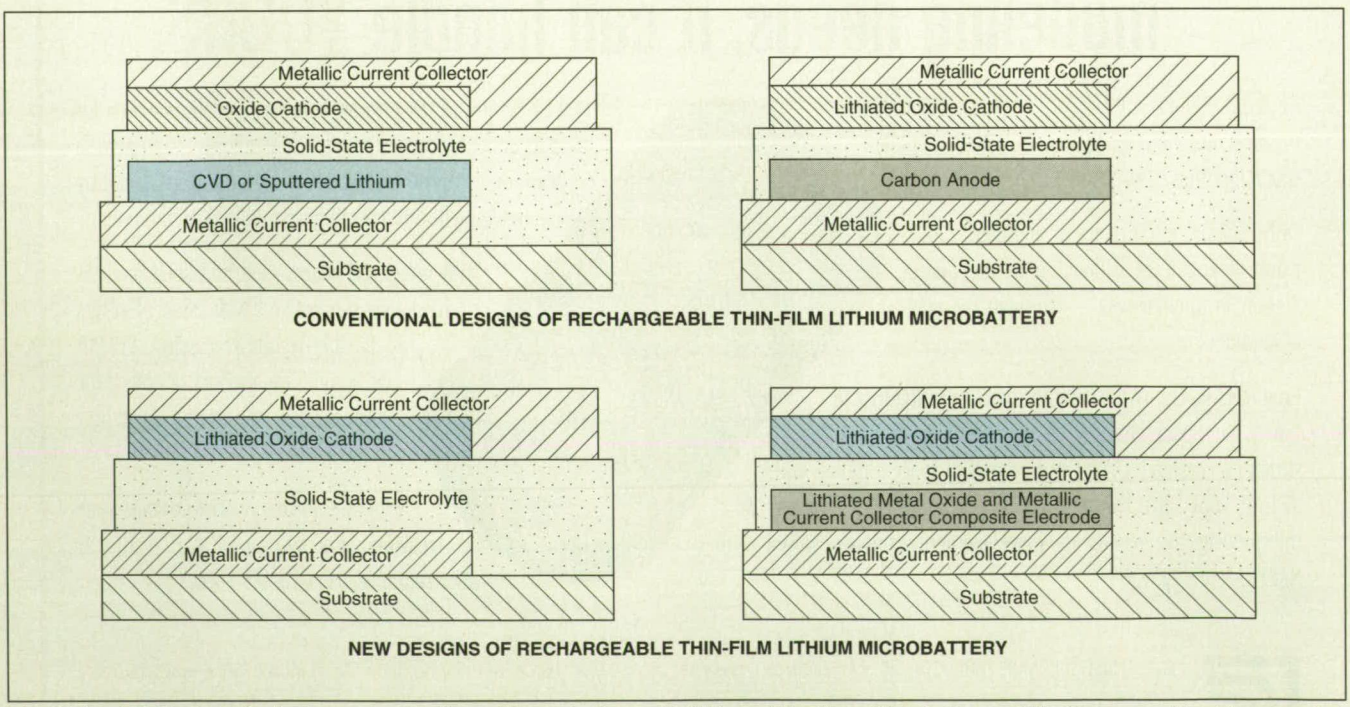
Rechargeable, thin-film, lithium-based microbatteries are potentially useful as power sources on integrated-circuit chips. For example, they could provide standby power for complementary oxide/semiconductor memory chips. The advantages of lithium-based microbatteries over typical power sources include the following:

- They can be fabricated in a variety of shapes;
- Because they are all-solid-state, there is no worry about gaseous components generated during operation;
- They feature high energy and power densities; and
- They can endure large numbers of charge/discharge cycles.

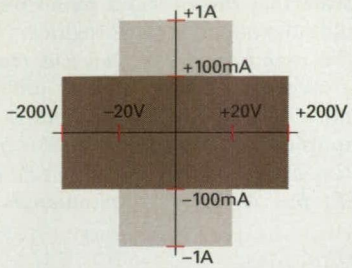
The figure schematically illustrates the structures of cells in alternative versions of the state-of-the-art and the proposed rechargeable, thin-film, lithium-based batteries. In fabricating a state-of-the-art battery, the metallic lithium anodes are formed by chemical vapor deposition (CVD) or sputtering of lithium. The cathodes are made of TiS_2 or V_2O_5. The metallic lithium in the newly formed anodes is very chemically reactive with moisture and air; this poses a danger and can cause loss of usable lithium during later stages of fabrication. The fabrication process is complicated by the requirements of the deposition process and the need to take extreme care for safety and for preservation of the newly deposited lithium.

The difficulty, danger, and complexity by deposition of metallic lithium would not be present in the fabrication of a battery of the proposed type because lithium would not be used in metallic form during the fabrication process. Instead, the usable lithium stock in each cell would be intercalated into a metal oxide to make a cathode of lithiated metal oxide (for example, $LiCoO_2$, $LiNiO_2$, or $LiMn_2O_4$). The anode in each cell would be fabricated as either (1) a metallic Cu, Ni, or Ag current-collecting electrode formed by sputtering or CVD; or else (2) an electrode layer of composite material made by mixing a current-collector metal (Cu, Ag, or Ni) with a fully lithiated oxide (e.g., tungsten oxide). During subsequent charging, lithium ions would be deintercalated from the cathode, and metallic lithium would be plated onto the anode; this plating process would constitute the in situ formation of lithium mentioned above.

The solid electrolyte in the proposed cells could be $Li_{3.3}PO_{3.8}N_{0.22}$, which is used in the state-of-the-art cells. Alternatively, the solid electrolyte could be Li_5SiP_3 or Li_8SiP_4. If necessary, the proposed microbatteries could be encapsulated with electrically insulating materi-



The **Lithiated Oxide Cathodes** in the proposed cells would contain the usable lithium at the time of fabrication; metallic lithium would not be present at the time of fabrication as it is in state-of-the-art cells.



Source and measure capabilities

First we doubled the function,

Model 2400

Model 2410

Model 2420

now we've tripled the choice.

Just like the original Model 2400, the two new additions to the Keithley SourceMeter® line combine sourcing and measurement in single, high throughput, DC parametric test systems. The high voltage Model 2410 and high current Model 2420 extend the range of these capabilities for high speed, precision testing of a wider range of electrical components, giving you a better return on investment. In addition, you can bundle each member of the SourceMeter family with a broad selection of compatible accessories, including switching systems. The result is complete, efficient, multi-point solutions for production testing or off-line characterization.

For your free brochure, contact Keithley today.

SPEC DIRECT 1-800-936-3300
FAX 216-248-6168
TELEPHONE 1-800-552-1115
E-MAIL product_info@keithley.com
WEB http://www.keithley.com

KEITHLEY

Specifications

	Dynamic Range 2400	2410	2420	Max system speeds:	External interface:	1 year basic accuracy: (5½-digit resolution)	
Voltage	±200V	±1100V	±60V	Pass/fail = 500µs	IEEE-488 (SCPI)	Volts	0.01%
Current	±1A/20V	±1A/20V	±3A/20V	To memory = 500µs	RS-232	Amps	0.02%
	±100mA/200V	±20mA/1100V	±1A/60V	To IEEE-488 = 1ms	Digital I/O	Ohms	0.04%
Power	22W	22W	66W	Range change = 13ms	Component handler		

Internally programmable measurement sequence up to 100 points.

Peak Performance

The World's First Miniature Fiber Optic Spectrometer offers remarkable performance at an affordable price, with unmatched flexibility. Consider:

- High detector sensitivity -- ideal for low light level experiments from 200-1100 nm
- Great system stability -- ±0.001 AU over extended periods
- Excellent optical resolution -- to <0.5 nm (FHWM)
- Flexible integration times -- 4 milliseconds to 60 seconds
- Remarkable unit durability -- no moving parts

Ocean Optics is the leader in low-cost spectrometers and fiber optic components for OEM developers ... Call today for information on our OEM Program.

Ocean Optics, Inc.

Ocean Optics, Inc.
Tel: (813) 733-2447
Fax: (813) 733-3962
E-mail: Info@OceanOptics.com
Web: www.OceanOptics.com

For More Information Circle No. 414

als. Another option would be the use of carbon as an anode material, though at the present state of development, it appears that the lithiated metal oxides would offer superior performance.

This work was done by Chen-Kuo Huang and Shiao-Ping Yen of Caltech and Jeff Wolfenstine of UC Irvine for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 127*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office–JPL; (818) 354-5179. Refer to NPO-19778.

Lightweight Dual-Beam Reflector Antenna

The design addresses some partly overlapping and competing requirements.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure illustrates a lightweight composite-material dual-beam reflector antenna for the SeaWinds spaceborne scatterometer instrument, which operates in the K_u band and is designed to measure wind velocities at the surface of the ocean. The design of the antenna could also be of interest for terrestrial applications in that it addresses issues that are not unique to any particular application and that involve some overlap and competition between mechanical and electromagnetic-performance requirements.

The mechanical requirement is that the antenna be stiff enough to resist vibrations to an acceptable degree, as quantified by a vibrational-resonance frequency of at least 94 Hz. The basic electromagnetic-performance requirement is to generate two linearly polarized, independent beams at angles of 40° and 46° from the nadir when the reflector axis is aimed at 43° from the nadir. The inner beam (the one at 40°) must be horizontally polarized and have widths of 1.6° and 1.8° in the azimuth and elevation planes, respectively. The outer beam (the one at 46°) must be vertically polarized and have widths of 1.4° and 1.7° in the azimuth and elevation planes, respectively. The first sidelobe of each beam is required to be at least 15 dB below the peak of the beam.

This **Dual-Beam Reflector Antenna** features a lightweight composite-material structure. The aperture is elliptical, with major and minor axes of 1.07 and 0.96 m, respectively. The total mass is only 6.4 kg.

The reflector surface is a paraboloid with an elliptical aperture. Two offset feeds (one for each beam) are mounted on a feed-support plate held by struts. To satisfy the stiffness requirement, the struts had to be made wider and the feed-support plate larger than in an ordinary design for an antenna of this type. It was found that, in the absence of corrective measures, (1) the increase in aperture blockage caused by enlargement of the feed-support plate and (2) interactions between the feed horns and the enlarged feed-support plate would result in sidelobe levels higher than allowed under the performance requirements, lower antenna gain, and altered beam widths.

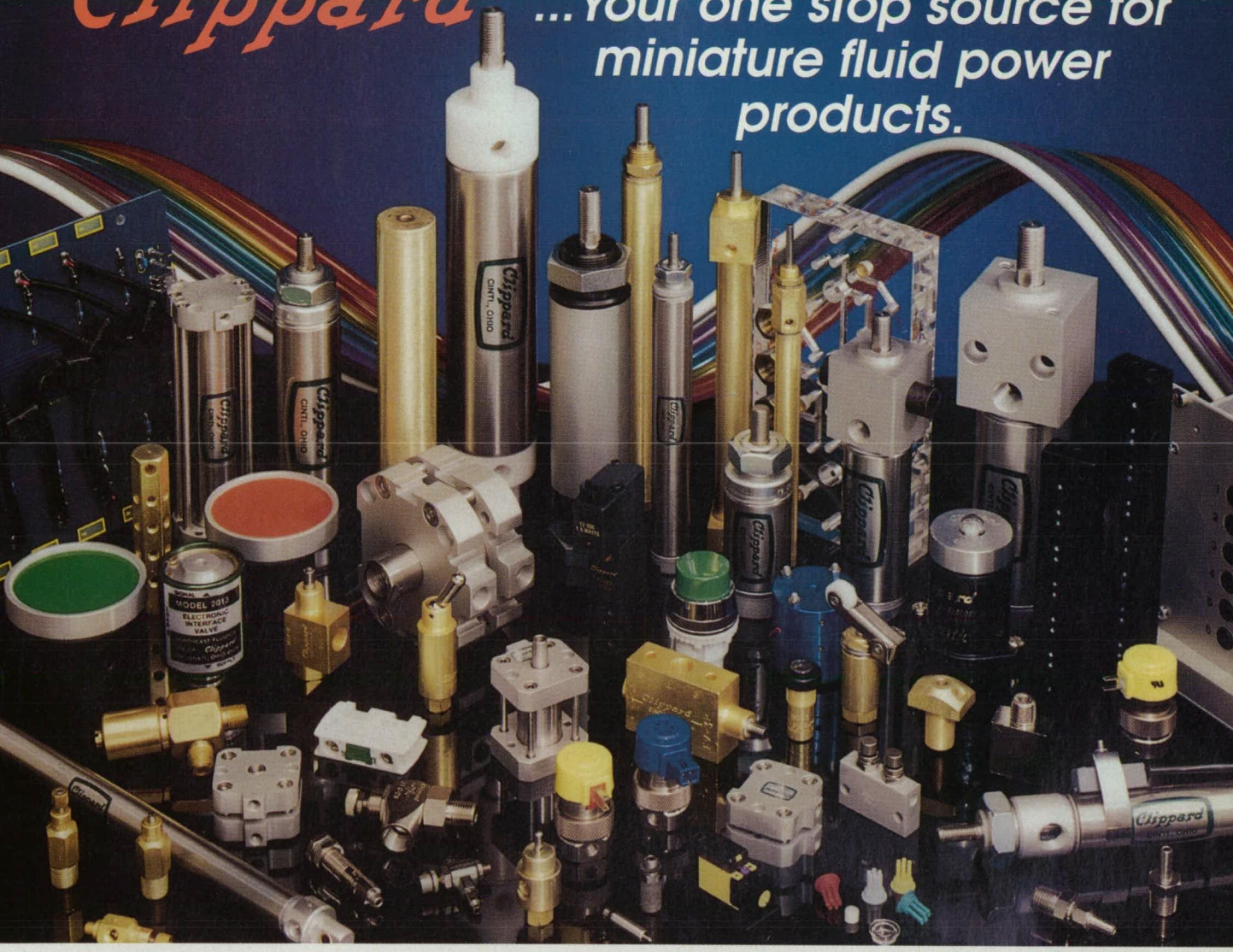
By a combination of theory and experiment, it was found that suitable corrective measures would include coating the feed-support plate with an absorbing material, extending the inner-beam feed horn, and adding a choke around the outer-beam feed horn. Tests showed that these measures reduced sidelobe to the required levels and afforded some improvements in gain and beam widths.

This work was done by Ziad Hussein, Yahya Rahmat-Samii, and Kent Kellogg of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 113*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

NPO-20161

Clippard

...Your one stop source for miniature fluid power products.



Contact us or your area Clippard distributor for these free catalogs:

- ☑ **Minimatic® Valves**
  Catalog 189 **Circle 621**
- ☑ **Minimatic® Cylinders**
  Catalog 281 **Circle 622**
- ☑ **Minimatic® Fittings**
  Catalog 378 **Circle 623**
- ☑ **Modular Components**
  Catalog 484 **Circle 624**
- ☑ **Eagle Electronic 3 & 4 Way Valves**
  Catalog 590 **Circle 625**
- ☑ **The CILinder: Stainless Steel Cylinders**
  Catalog 789 **Circle 626**
- ☑ **Minimatic® Push Buttons**
  Catalog 884 **Circle 627**
- ☑ **Minimatic® Electronic/Pneumatic Interface Valves**
  Catalog 984 **Circle 628**
- ☑ **Electronic Manifold Cards**
  Catalog 1086 **Circle 629**
- ☑ **Pneumatic Circuit Boards**
  Catalog 1392 **Circle 630**

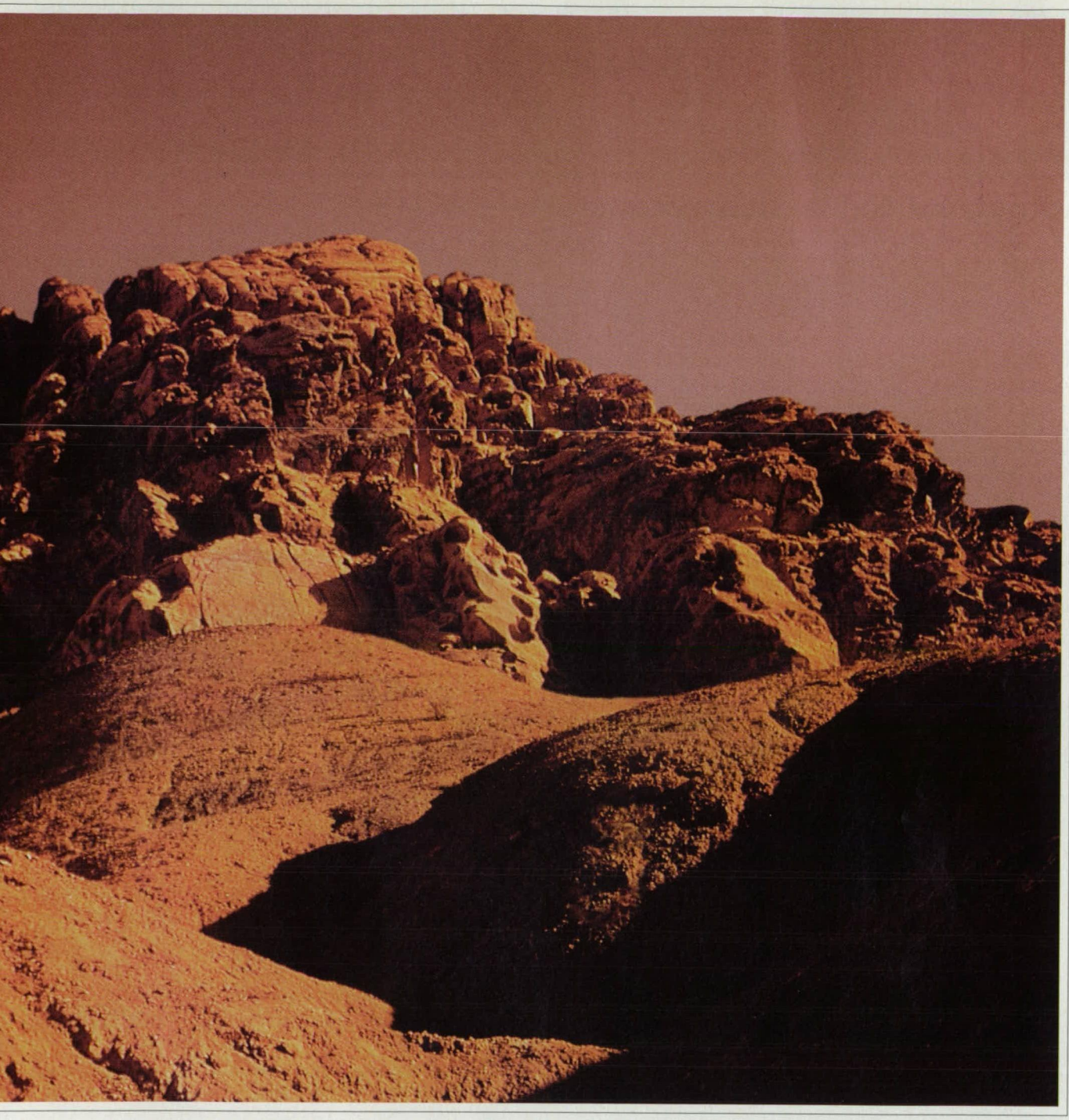
From a Name You Can Trust...

Clippard Instrument Laboratory, Inc.

7356 Colerain Avenue • Cincinnati, Ohio 45239

Phone (513) 521-4261 Fax (513) 521-4464 http://www.clippard.com

How far do you want to go?



©1997 Lockheed Martin Corporation

It's not a destination. It's more like America's destiny. And NASA is leading the way. Our Consolidated Space Operations Contract team will play a vital role every step of the way. With our unmatched space operations experience and expertise, we will help NASA realize significant reductions in operating expenses. Letting NASA focus on what it does best: explore the heavens.

LOCKHEED MARTIN

CSOC

AlliedSignal AEROSPACE BOOZ·ALLEN & HAMILTON CSC GTE

For More Information Circle No. 540

Automated Cable-Analyzer System — ACAS

A computer-controlled time-domain reflectometer locates faults in multiconductor cables.

Lyndon B. Johnson Space Center, Houston, Texas

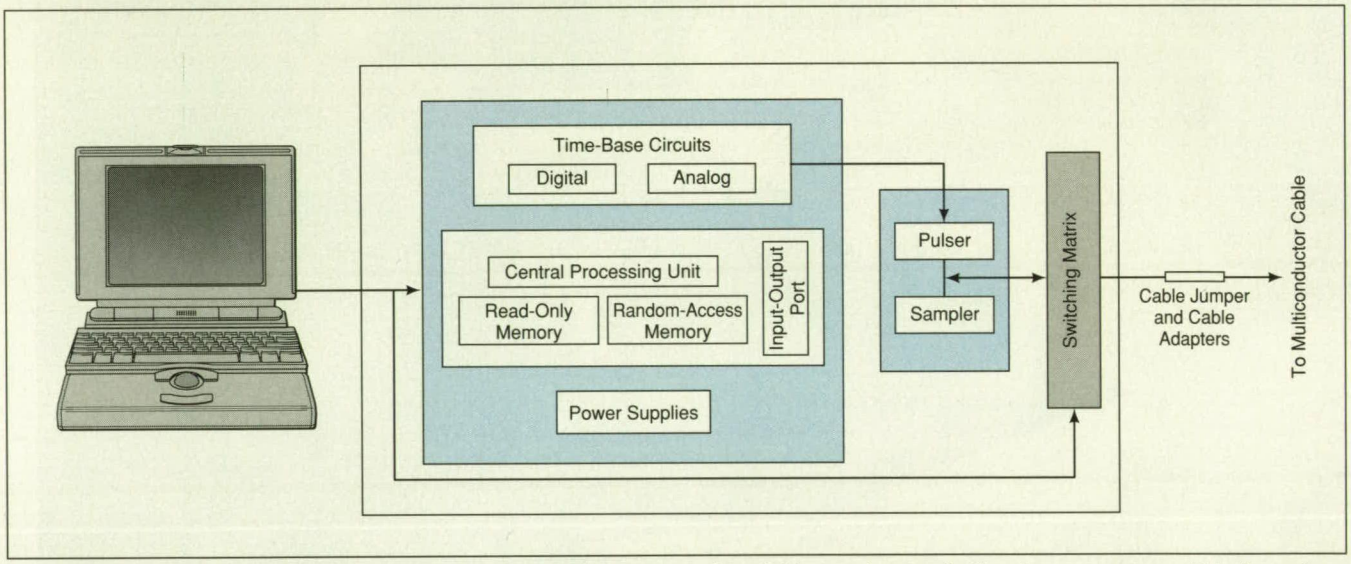
An instrumentation system automates the detection and location of faults in multiconductor electrical cables. It can accelerate diagnoses of aircraft, automotive, or industrial cables, while reducing the incidence of errors and of damage caused by test probes.

The system (see figure) includes a time-domain reflectometer (TDR), which is a conventional pulse/echo cable-testing instrument. The system also includes a switching matrix containing relay switches, power-supply circuitry, a cable jumper and an assortment of adapters for mating to a variety of cables, digital control circuitry, and a computer that performs control and data-processing functions. The computer can be programmed to automatically cause the switching matrix to connect the ACAS to different pairs of wires in the cable under test and to analyze and store the measured data.

When connected to the various pairs of wires, the ACAS launches pulses into the cables and samples the reflections. The digitized reflection signals are processed to locate faults, using a real-time algorithm and/or a more thorough post-processing algorithm. Optionally, post-processing can include comparisons with data acquired previously from cables in known conditions.

This work was done by Michael T. Pham of **Johnson Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 122*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

MSC-22651



The **Automated Cable-Analyzer System** includes a time-domain reflectometer and a switching matrix controlled by a laptop computer, which also analyzes the test data. The switching matrix addresses designated pairs of wires in the cable, in a sequence specified via software.

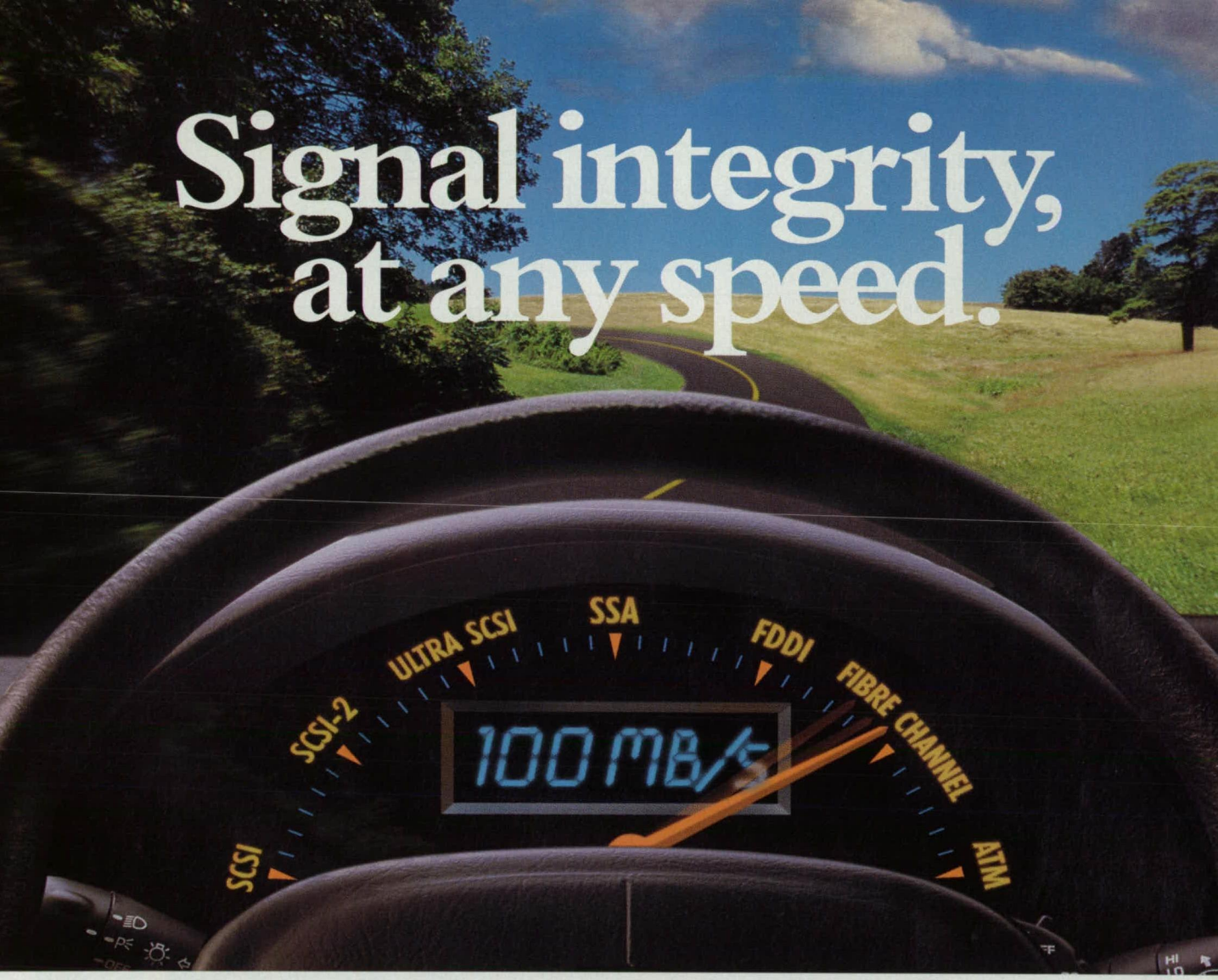
Optical Horizontal-Displacement Sensors for Crane Payloads

It is not necessary to run wires along the crane cables.

John F. Kennedy Space Center, Florida

Sensors made largely of commercially available optical and electronic components are being developed for use in measuring small horizontal displacements of payloads suspended below cranes at the ends of nominally vertical cables. The outputs of these sensors would be used in computer-based automated and manual crane-control systems to guide the horizontal movements of the cranes with respect to the payloads or with respect to nearby objects. For example, in the original intended application, the horizontal displacement would be produced by manually pushing a heavy payload in a desired direction, and the output of an optoelectronic sensor that measured this displacement would be sent to a computer-based crane-control system, which would apply power to move the crane in that direction.

A sensor of this type includes a source of a well-defined beam of light (e.g., a diode laser and beam-expanding optics) mounted on the crane at the upper end of the cable, nearby



High-speed signal integrity is a high-risk proposition, where interconnect systems make the difference between data and disaster.

We've spent decades developing advanced connector systems for advancing technology: first copper, then fiber, and now wireless applications. It's taught us how to make high speed and signal integrity travel safely together. In interconnect design. In end-to-end simulation. And in subassembly fabrication.

What we know, and do, is available for your current project. As complete interconnect solutions. Or for any element of your interconnect system.

Comprehensive Engineering Services

- Board-level design
- Custom interconnect systems
- Simulation and modeling
- Mechanical enclosure design and fabrication
- Packaging and assembly
- Printed circuit fabrication
- Manufacturability review

From board-level design to complete subsystem packaging, we're ready to work, and make it work, for you.

AMP Incorporated. Contact your regional center: USA 1-800-522-6752. Canada 905-470-4425. Europe, Middle East, Africa +44 1753 676800. Singapore 65-4820311.

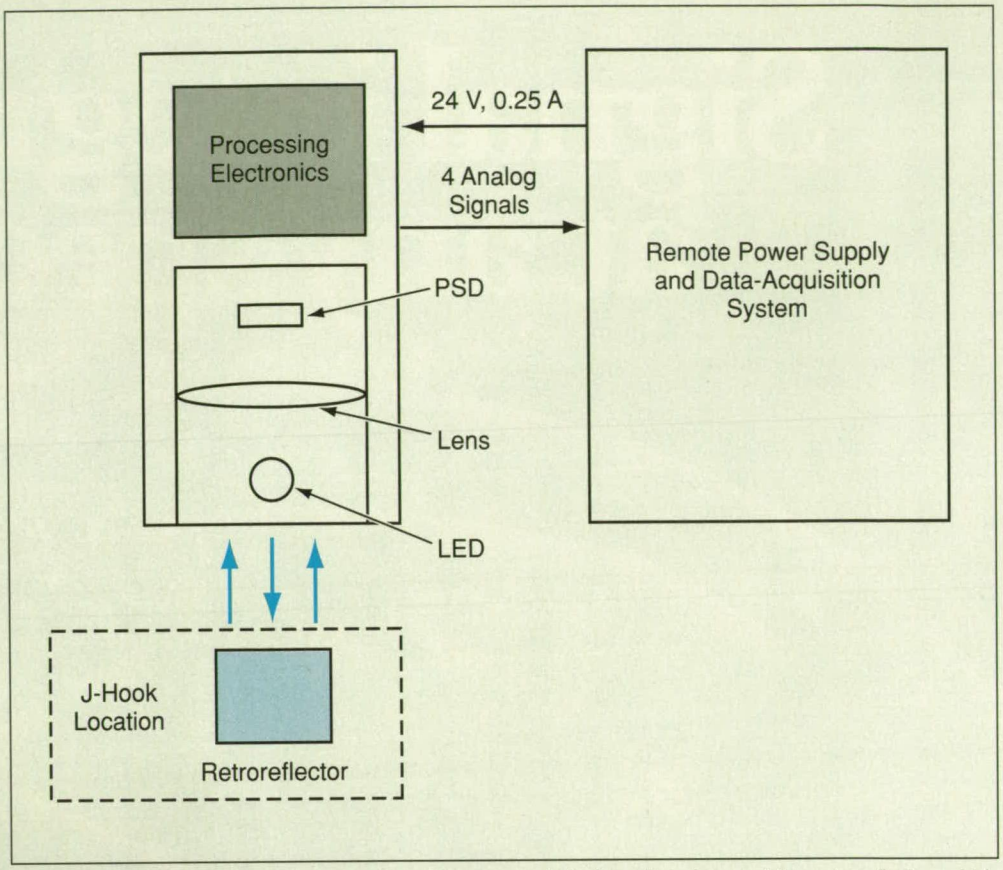
www.amp.com

AMP and Connecting at a Higher level are trademarks.

Connecting at a HIGHER level.
AMP

photodetectors off to the sides of the source of light, and a corner-cube reflector mounted on the hook or payload at the lower end of the cable. An important advantage of this sensor concept (see figure) is that it is not necessary to run wires along the cable to supply power to a transducer at the payload end.

A corner-cube reflector is a standard, commercially available retroreflector. It sends light back toward the source along a direction parallel to the direction of incidence, laterally offset by the lateral distance between the point of incidence and the point of final reflection. The lateral offset of the reflected beam equals twice the lateral displacement of the apex of the corner cube from the centerline of the beam of light from the source. When one of the photodetectors intercepts the reflected light, that photodetector responds, signifying that the payload has been laterally displaced from the



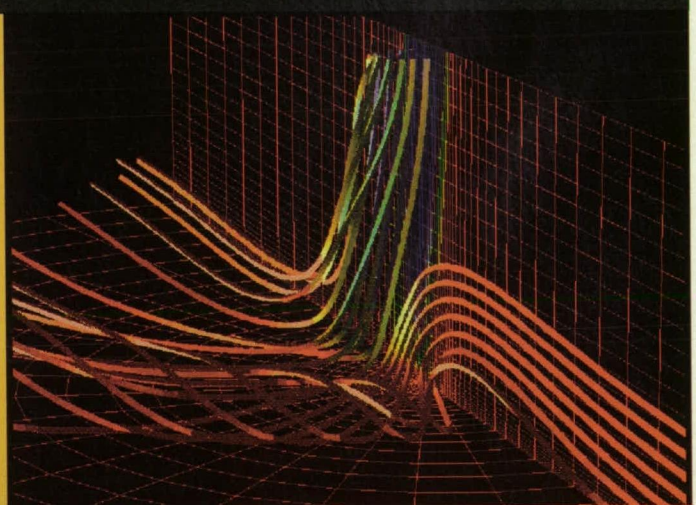
In this proof-of-concept diagram of **Crane-Position Sensor,** light is projected toward the retroreflector, which reflects it back to the position-sensitive detector (PSD), monitoring the location of the reflection site.

FINALLY, A SOLUTION THAT'S MORE THAN JUST A PRETTY PICTURE.

Amtec®

TECPLOT® Version 7 can solve your day-to-day plotting and data visualization problems, with ease.

More than 10,000 engineers and scientists trust Tecplot to successfully visualize, analyze, and present their data. Designed by engineers for engineers, Tecplot combines power, speed, and a comprehensive set of features to boost your productivity. Visit our Web site or give us a call today to see why Tecplot sets the new standard in engineering plotting and data visualization for Windows NT/95 and UNIX users.



AMTEC ENGINEERING

800.676.7568

WWW.AMTEC.COM FREE DEMO!

VERSION TECPLOT 7

Amtec and Tecplot are registered trademarks of Amtec Engineering, Inc. of Washington, USA.

Thumbs Way Way Up!

Critics rave about the TDZ 2000, the ultimate graphics workstation.

Editors' Choice: "...a well-balanced system with top performance..."
— PC Magazine, *February 24, 1998*

BYTE BEST 300 MHz NT Workstation and Best Overall System: "The indisputable champ"
— BYTE, *January 1998*

Editor's Choice Award: "...the box to beat for 1998."
— 3D Design, *January 1998*

"kick ass! product" Editors' Choice Award: "...a leviathan of an NT workstation that brims with power."
—boot, *January 1998*

5 Star Rating: "Intergraph is obsessive about pushing the limits of 3D graphics, and it shows..."
— Digital Magic, *December 1997*

Recommended for Engineering: "...the top engineering workstation... the best graphics performance ... ready to take on the toughest of 3D graphics and CAD work."
— PC Digest Ratings Report, *November 1997*

Editor's Choice Award: "The TDZ 2000 series of 3D graphics workstations puts an impressive number of capabilities into a range of reasonably priced boxes."
— AV Video and Multimedia Producer, *October 1997*

"Awesome" rating: "The TDZ 2000 combines a smart new two-part tower design with top 3D and processor performance."
— New Media, *December 1997*

Prime Time Products Award: "...upping the ante for 3D graphics in the NT workstation market."
— AdvanStar Publications SIGGRAPH '97, *August 1997*

For More Information Circle No. 548

TDZ 2000 from Intergraph Computer Systems. The world's fastest Windows NT graphics workstation. Powered by Intel's Pentium® II processor. Award-winning design. Blistering 2D and 3D graphics. Best price/performance. Now available with a choice of high-performance graphics options for a broader range of applications. Team your most demanding applications with the ultimate graphics workstation family.

Call **1-800-763-0242**, or reach us on the Internet at **www.intergraph.com/ics**.

INTERGRAPH
COMPUTER SYSTEMS

MMX™ intel inside pentium® II PROCESSOR

Intergraph and the Intergraph logo are registered trademarks and TDZ is a trademark of Intergraph Corporation. The Intel Inside Logo, Intel and Pentium are registered trademarks of Intel Corporation. Windows is a registered trademark of Microsoft Corporation. Other brands and product names are trademarks of their respective owners. Copyright 1998 Intergraph Corporation, Huntsville, AL 35894-0001 MC980014

centerline in the same direction and by half the distance of the photodetector from the centerline.

An alternative approach utilizes a two-dimensional position-sensitive detector (PSD) to produce a set of four analog signals indicative of the lateral location of the retroreflector. PSDs are solid-state silicon photodetectors, which produce multiple currents whose magnitudes are proportional to the location of the centroid of the light impinging upon them. In this second approach, a high-brightness light-emitting diode (LED) is modulated at a few kilohertz and aimed at a retroreflector attached to the J-hook as shown in the figure. The reflected light is imaged by a lens onto the PSD, which after signal processing, yields four analog signals indicative of the location of the retroreflector. This approach has been demonstrated to yield accurate position location to better than 0.25 in. (6.35 mm) within a 3-ft (91.44-cm) field of view, at a distance of 30 ft (9.14 m).

This work was done by Ivan Velez of **Kennedy Space Center** *and William D. Haskell, Jimmy D. Polk, Robert B. Cox, Jim Strobel, Steve Thayer, and Robert C. Youngquist of I-NET, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 192*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-6225. Refer to KSC-11794.

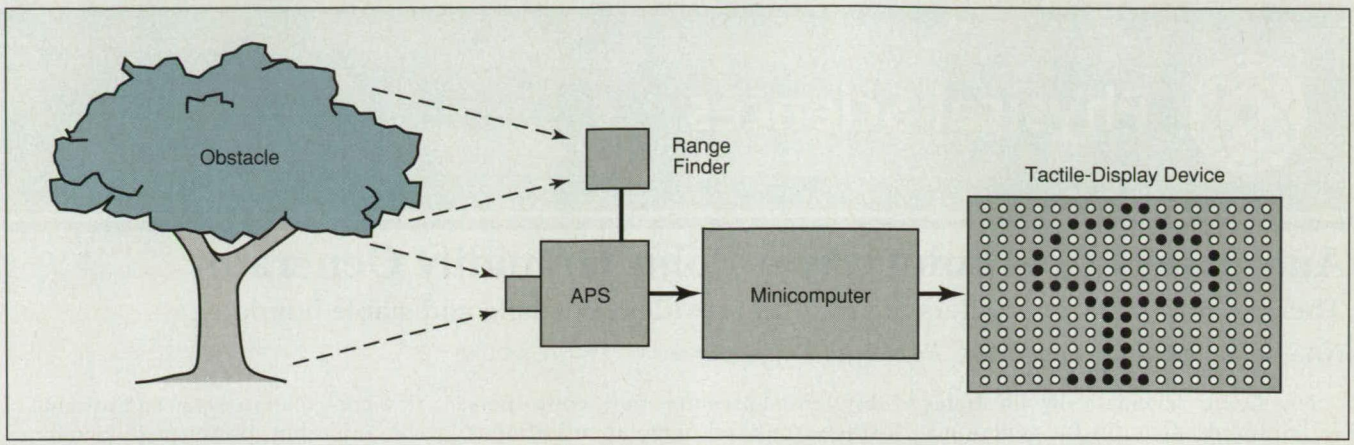
Sight-to-Touch Translator

The tactile principle of Braille printing would be adapted to avoidance of obstacles.

NASA's Jet Propulsion Laboratory, Pasadena, California

The sight-to-touch translator (ST^3) is a conceptual electronic apparatus that would generate a tactile representation of visible objects in its vicinity. The ST^3 would be worn by a blind person; the tactile display would help the wearer to visualize nearby obstacles and act to avoid them. Thus, the ST^3 might serve as an electronic alternative to a guide dog under some circumstances.

The ST^3 concept has become feasible in recent years, through advances in miniaturized image-detecting electronic devices, processing of image data, and microelectronics in general. The ST^3 (see figure) would include a state-of-the-art active-pixel sensor (APS) as its image detector. The output of the APS would be digitized and fed to a minicomputer, wherein the image data would be processed through edge-enhancement and gray-scale-based clutter-detection algorithms. The com-



The **Sight-to-Touch Translator** would translate the image of a nearby object into a tactile dot representation, which would have characteristics of both Braille and dot-matrix printing.

puter output would comprise data on the outlines of obstacles and other objects in front of the wearer.

The outline data would command the generation of a tactile dot representation of the outline of the object onto a rectangular electromechanical tactile-display device that would look like a giant dot-matrix printing mechanism. The tactile-display device would have dimensions of about 6 by 10 cm and would be mounted on the wearer's chest, forehead, or other convenient sensitive skin area that would provide a direction reference.

The ST[3] would include a range finder similar to the range finders on autofocus cameras. Inasmuch as only nearby objects would be of interest for avoiding obstacles, the output of the range finder would be used to limit the processing of image data to those parts of the scene that lie within a distance of about 5 m.

Alternatively or in addition to tactile dot representations of the outlines of obstacles, the apparatus could generate standard tactile dot patterns, analogous to Braille characters, to represent stairs, curbs, doorways, vertical obstacles, and other common objects that the image-processing software would recognize by correlation with previously acquired image data stored in the computer memory. The apparatus could also be made to generate audible signals based on the detection of specified colors in specified configurations (e.g. from traffic lights and illuminated exit signs).

This work was done by Philip I. Moynihan and Maurice L. Langevin of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 111*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-20230

Prototyping?
Use ARRK
because mediocrity is unacceptable
ARRK®
PRODUCT DEVELOPMENT SERVICES
800-735-ARRK
http://www.arrk.com/~arrksd/
See us at The National Design Engineering Show, Booth #4580

Automated Dew-Point/Frost-Point Humidity Generator

Thermal mass-flow controllers are used to provide repeatable and stable humidity.

NASA's Jet Propulsion Laboratory, Pasadena, California

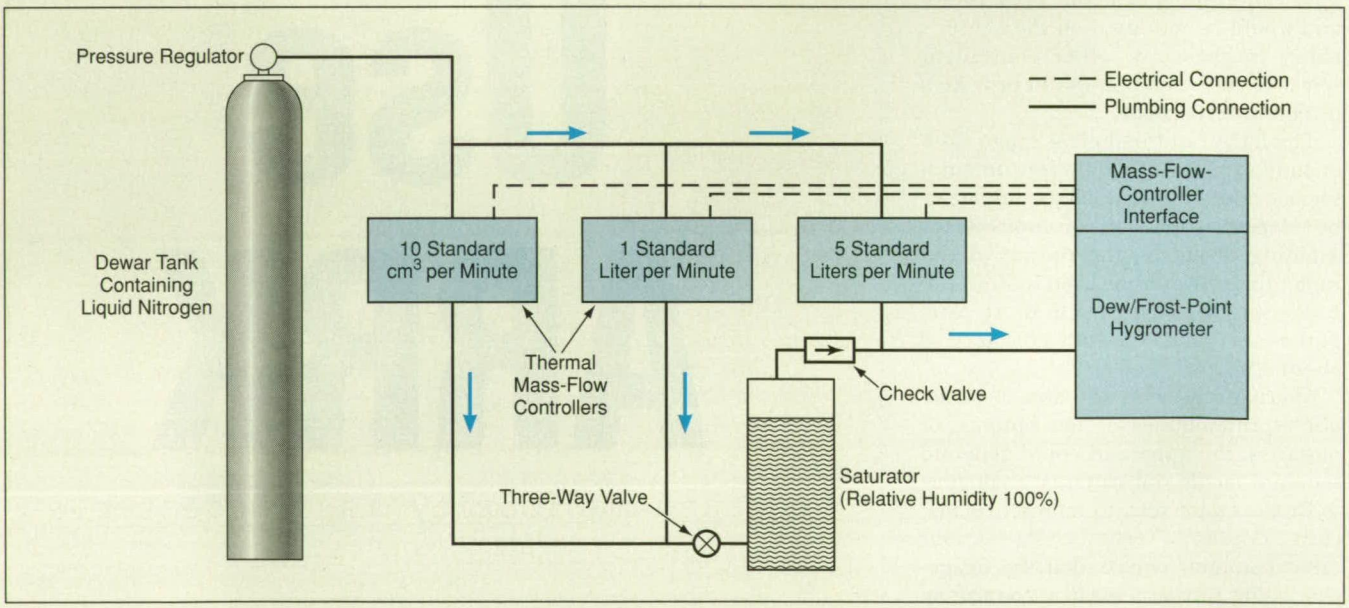
The figure schematically illustrates an improved apparatus for generating a flow of gas with precise, stable humidity. Such flows are needed for calibration of dew-point, frost-point, and other humidity sensors.

Like a prior humidity generator, this apparatus utilizes a divided-flow technique, in which an initially dry gas to be humidified is divided into two streams, one stream is humidified in a saturator, then the two streams are recombined to obtain a single stream with the required humidity. The flows in the prior humidity generator were regulated by use of differential-pressure flow controllers, which required manual adjustment, were highly unstable, and gave nonrepeatable flow rates. In addition, the proper operation of the prior humidity generator depended on constant attention by a technician to perform hygrometer calibrations.

The instability and imprecision of the prior humidity generator are eliminated in the improved apparatus by replacing the differential-pressure flow controllers with thermal mass-flow controllers that, in turn, can be controlled by a computer. In addition, the mass-flow controllers are placed upstream of the saturator, preventing contamination and increasing stability. These two innovations provide much greater precision in the flow rates used to produce desired levels of humidity. The improvements also reduce the labor time needed to perform a hygrometer calibration from 8 hours to about 2 hours.

This work was done by Miguel Cerezo of Caltech for **NASA's Jet Propulsion Laboratory.** *No further documentation is available.*

NPO-19935



Thermal Mass-Flow Controllers are used instead of differential-pressure mass-flow controllers, and are placed upstream of the saturator.

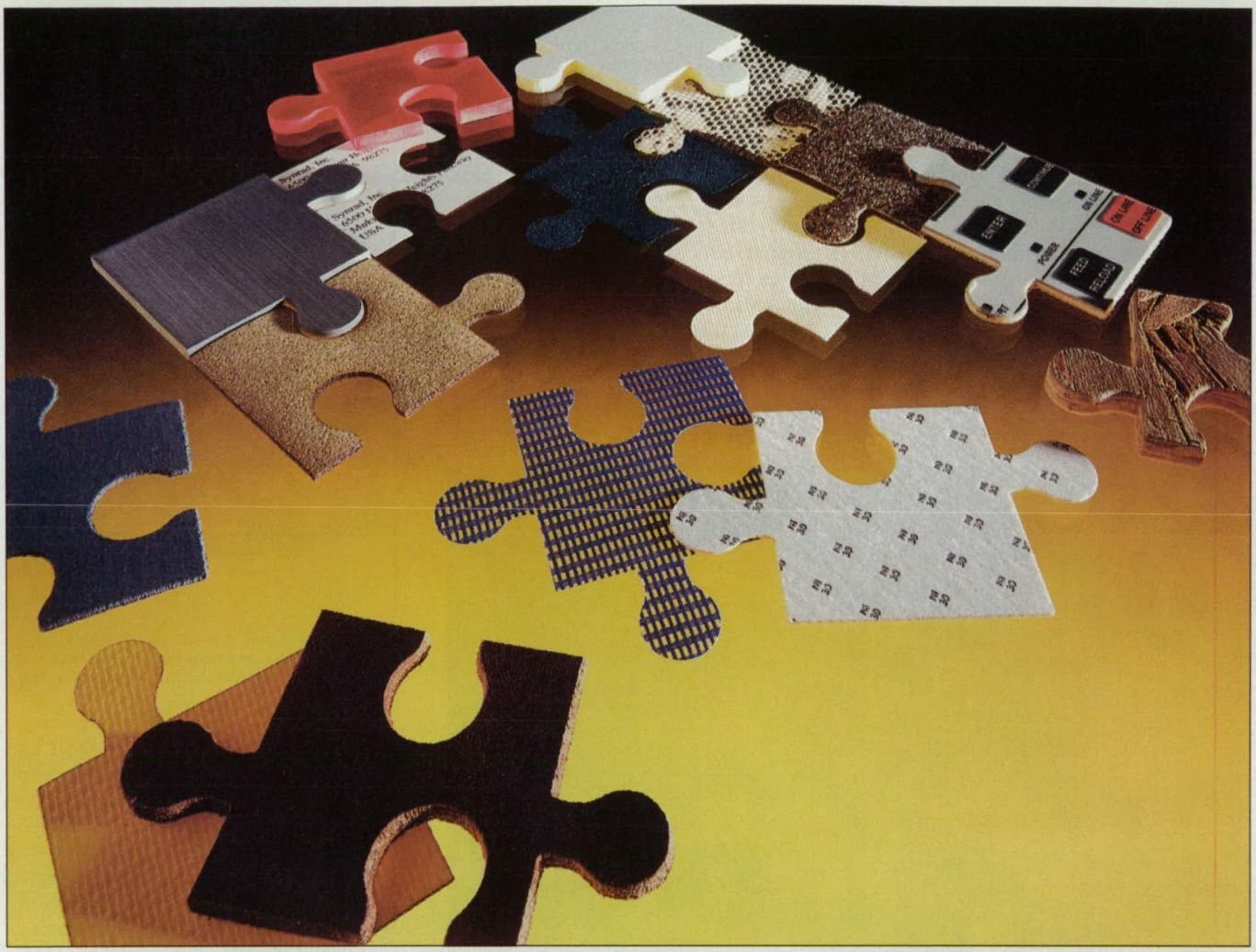
Improving Distributions of Flux in Solar Thermal Receivers

Concentrated radiant flux would be absorbed and reradiated by shields.

Lyndon B. Johnson Space Center, Houston, Texas

A modification of design has been proposed to extend the longevity of cavity-type solar thermal receivers by improving the distribution of radiant solar flux in the cavities. A receiver of this type is used in conjunction with a solar concentrator, which is a mirror that focuses the radiant solar flux into the cavity. A large part of the radiant flux is absorbed on the inner cavity walls and is thereby converted to usable heat. Inevitably, imperfections in the surface of the concentrator give rise to a maldistribution of flux in the cavity — hot spots — that shorten the useful life of the receiver.

The proposed modification consists mainly of the addition of a thermally conductive, thermally emissive radiant shield between the aperture and the walls of the cavity (see figure) to even



Still puzzled about how to cut or mark your product?

Steel, labels, acrylic, foam, cork, leather, fabric, lace, gaskets, sail cloth, nylon, sandpaper, vinyl, specialty paper, wood, and plastic. Every day over 15,000 Synrad CO_2 lasers cut, drill and mark these and many other materials. Applications are practically boundless—the more you learn about our lasers, the more uses you will find for them.

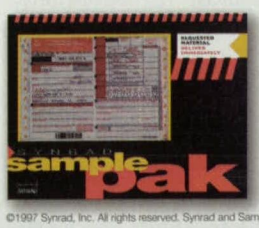
Simple to use with the reliability demanded by the toughest industrial applications. No gas bottles to replace, tools to resharpen or nozzles to clean—our lasers offer maintenance-free operation 24 hours a day for over four years. That's why Synrad lasers cost less to buy and run than other technologies.

Integrating our lasers into your existing application is easy. We design our CO_2 lasers to be components—think of them as light bulbs—to mate with XY tables, gantry systems, or robot arms. No major redesigns are necessary to obtain the benefits of laser processing. Our all-sealed technology means no adjustments or alignment problems—ever.

Eliminate die cutters, blades, scribers or ink. The small focused laser beam produces sharp, clean edges and, as the process is non-contact, intricate patterns can be cut in thin, delicate materials with no drag—even at high speeds. CO_2 lasers can offer increased precision, higher processing speeds and less waste.

Never used a laser before? Neither had most of our customers before talking to us. To learn how sealed CO_2 lasers can help improve your process quality and reduce your manufacturing time and costs, call **1.800.SYNRAD1** today.

www.synrad.com



Send us your samples for a FREE Process Evaluation

Can you benefit from laser technology? Find out by sending us samples (remember to include a description of your current process and, if possible, an example of a "finished" product). Within 3–5 days you'll receive a Synrad SamplePak™ containing your samples (suitably marked, drilled or cut by our Applications Facility), a written Materials Evaluation and more information on implementing laser technology.

SYNRAD™

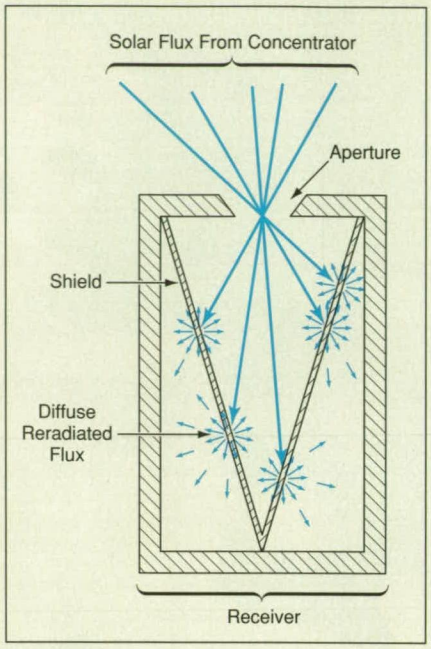
6500 Harbour Heights Parkway
Mukilteo, Washington 98275 USA
425.349.3500 tel 425.485.4882 fax

©1997 Synrad, Inc. All rights reserved. Synrad and SamplePak are trademarks of Synrad, Inc.

out the hot spots. Concentrated solar flux would enter the cavity through the aperture in the usual way, but would be initially absorbed on the shield and would thus initially heat the shield instead of the inner cavity walls. The heat would be conducted through the shield from the side facing the aperture to the side facing the inner cavity walls.

Being hot on both sides [typical temperature of 1,550 °F (843 °C)], the shield would reradiate diffusely toward the inner cavity walls, toward the aperture, and toward facing parts of the shield itself. The diffuseness of the reradiation would diffuse the hot spots, so that the temperature [typical temperature 1,400 °F (760 °C)] around the circumference of the inner wall would be more nearly even.

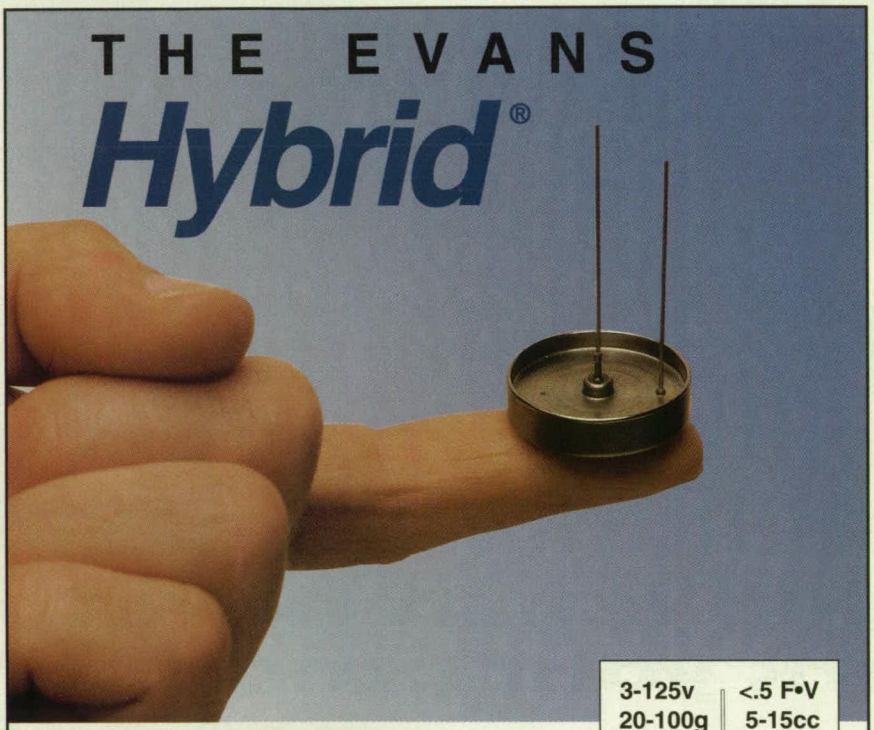
The fraction of reradiated heat lost through the aperture would be greater than it is in a comparable receiver of unmodified design (without a shield). However, the loss could be reduced to a few percent or perhaps eliminated by suitable choice of the size and shape of the shield, the rest of the receiver, and the concentrator. In any event, the economic disadvantage of the small loss of energy-conversion efficiency may be more than offset by economic advantages of (1) the increase in useful life and (2) the decrease in cost of the concentrator occasioned by elimination of the need to carefully tailor the concentrated flux to minimize hot spots.



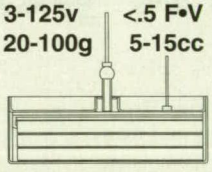
The **Shield Would Absorb** concentrated solar radiant flux and reradiate heat diffusely to the cavity walls, thus evening out hot spots in the concentrated flux.

This work was done by Charles T. Kudija of Rockwell International Corp. for **Johnson Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 175*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
MSC-22553

THE EVANS
Hybrid®



3-125v 20-100g
<.5 F•V 5-15cc



A smaller, lighter, and more powerful capacitor.

EVANS

The Evans Capacitor Company
P. O. Box 14158
East Providence, RI 02914-0158
(401) 434-5600 Fax (401) 434-6908
www.evanscap.com

The new Evans Hybrid® is an electrolytic-electrochemical capacitor with incredible properties:

- As little as 1/10 the volume of aluminum electrolytics
- 1/2 the weight of aluminum electrolytics

In two design styles, a hermetic tantalum package and a polypropylene package, Evans Hybrids are excellent for avionics, power supplies, power filtering, communications, weapons systems, medical applications, auto auxiliary systems and many very special uses.

Hybrids are designed and manufactured by the Evans Capacitor Company, known for the Capattery®, the world's leading electrochemical capacitor.

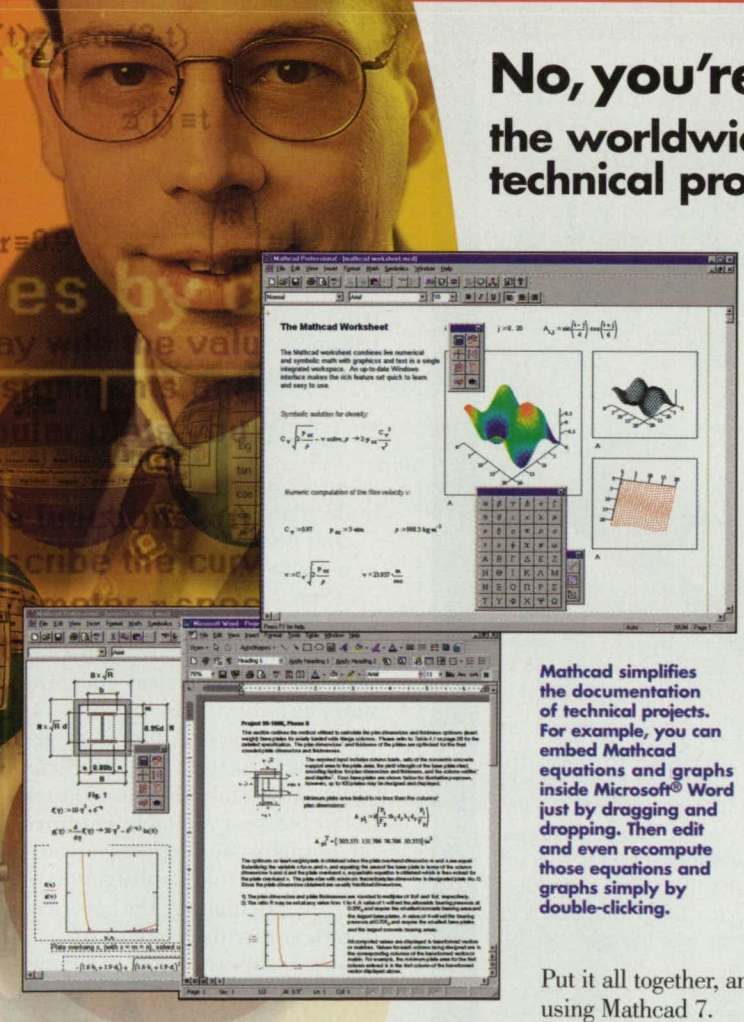
Equations of State for Fluid Mixtures at High Pressures

This method is particularly applicable to gas turbine and rocket engines.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method that includes the use of modified equations of state has been developed to enable noniterative, efficient computation of the thermodynamic behaviors of gases and liquids at temperatures ≥100 K and pressures from 1 to 100 MPa. The method is intended to be particularly useful for calculating such quantities as partial molar volumes, enthalpies, entropies,

You're writing equations in real math notation. Adding graphs and text wherever you like. Changing variables and getting the new results instantly. Are you dreaming?



No, you're using Mathcad® 7, the worldwide standard for technical professionals

Mathcad gives you a wide choice of tools and supports a variety of analysis and visualization techniques. Even experienced users constantly discover new ways of using it. Access math operators from the updated math palettes, or just type any function directly. Mathcad 7 Professional handles matrix arithmetic, the operations of calculus, complex numbers, and all of the math most engineers and scientists need.

Why is Mathcad the world's best-selling calculation package for technical professionals? Because it's the only one with the kind of free-form, interactive environment you need to formulate models, set up problems and evolve solutions. Quickly and easily. In fact, Mathcad is a lot like a pencil and scratchpad, only it's powered by a microprocessor instead of your own overworked mind.

Mathcad simplifies the documentation of technical projects. For example, you can embed Mathcad equations and graphs inside Microsoft® Word just by dragging and dropping. Then edit and even recompute those equations and graphs simply by double-clicking.

What's more, new Mathcad 7 comes with a long list of improvements that make it better than ever. Like increased power. A more refined interface. New interoperability with Excel and MATLAB™. Additional data input/output capabilities. A richer programming environment. More online technical content. And full Web integration — with Microsoft® Internet Explorer built right in.

Put it all together, and you'll see why it's time to wake up. And start using Mathcad 7.

Get Mathcad 7 today at one of the retailers below.
Or visit www.mathsoft.com for more information.
For volume licensing, call 1-800-MATHCAD.

COMPUTER City · SOFTWARE SPECTRUM · COMPUSA · SciTech SOFTWARE FOR SCIENCE · ADEPT SCIENTIFIC · Softmart · Stream · MICRO CENTER

Copyright 1998. MathSoft, Inc. All rights reserved. Mathcad is a registered trademark and MathConnex is a trademark of MathSoft, Inc. All other trademarks are the property of their respective owners.

Substance	Temperature Range, K	Pressure Range, MPa	Maximum rms Relative Error (Percent at Fixed Pressure)		
			Enthalpy	Entropy	*pv/RT*
Hydrogen	80 to 400	0.1 to 100	0.23	0.15	1.0
Oxygen	100 to 400	0.1 to 100	1.1	0.2	1.4
Nitrogen	100 to 2000	0.1 to 100	0.22	0.22	0.7
Propane	100 to 600	0.1 to 100	2.9	0.5	2.0
Methane	100 to 600	1 to 30	0.9	0.3	1.0
N-heptane	210 to 1500	0.1 to 27	0.26	0.16	2.2
Methanol	210 to 1500	1 to 80	1.35	1.1	10

Reference-State Fits were made for seven substances in various pressure and temperature ranges. The fit for each substance is characterized by a maximum root-mean-square (rms) relative error at fixed pressure.

MUCH MORE THAN A PRETTY PICTURE (FRAME)

Our competitors say, "Oh, Cardinal's just a picture frame company!" Sure, we manufacture picture frames, but that's just *one* of the many markets where we shine. Just take a look at this 6-hole, multi-hollow extrusion piece...

MOST EXTRUDERS WOULDN'T EVEN QUOTE THE JOB ...

They claimed it was too difficult to *economically* manufacture due to its difficult shape, varying wall thicknesses, and extensive fabricating.

... BUT CARDINAL COULD, AND DID IT ALL!

Extruding the complex profile was the easy part. What kills our competition is their tremendous cost in tooling and the numerous set-ups ...

FABRICATED IN 10 MINUTES!

Our fully automated, multi-functional fabricating equipment allowed us to completely fabricate this component in one work cell in less than ten minutes!

THE BIG FINISH

Next we applied our standard decorative etch black anodize—one of over 20 anodizing colors available. We also offer over 60 stock powder coat finishes, five 2-step architectural hard coats, plus any custom match—all with the surface finish of your choice. And with our Image Graphics, your extrusions can look like *any* material!

ALL THIS FROM A SINGLE SOURCE ...

Extruding, fabricating, finishing—oh yea, and picture frames—it's all here at Cardinal, your single source for high-tech aluminum extrusions since 1946. Give us a call today.

1-800-EXTRUDE

Cardinal Aluminum Co.

6910 Preston Hwy. • P. O. Box 19987 • Louisville, KY • 40219-0987

1-800-EXTRUDE • Fax: (800) 969-6910

compressibilities, and thermal expansivities of oxidant/fuel mixtures at given pressures, temperatures, and mass fractions in gas turbine and rocket engines.

The method is based partly on the concept of a reference state of a real gas, which state is similar to that of a perfect gas at the same temperature and pressure and is defined with respect to the condition of the real gas at a relatively low reference pressure. The method is also based partly on the use of departure functions to represent the deviations of thermodynamic functions of the real gas at high pressure from reference-state values of those functions.

The form of the departure functions is obtained from the Peng-Robinson equation of state:

$$p = RT/(v - b_m) - a_m/\left(v^2 + 2b_m v - b_m^2\right),$$

where p is the absolute pressure, R is the molar ideal-gas constant, T is the absolute temperature, and v is the molar volume. The parameters a_m and b_m are semiempirical terms calculated from critical-state properties; these parameters follow conventional mixing rules; namely,

$$a_m = \sum\sum x_i x_j a_{ij} \text{ and } b_m = \sum x_i b_i,$$

where x_i is the mole fraction of the ith molecular species.

One first applies the departure-function formalism to each of the pure constituents of a mixture, then reuses this formalism for the mixture as a whole. In the application to each pure constituent, one expresses the reference-state enthalpy and entropy as finite series of temperature- and pressure-dependent terms, the coefficients of which are established by least-squares fits to the best available empirical data on enthalpy and entropy (see table). This method follows the standard practice in calculating the properties of nonideal mixtures by use of accurately known properties of the pure constituents along with excess Gibbs energy and/or fugacity coefficients, which are defined by use of conventional mixing rules.

This work was done by Josette Bellan, Richard S. Miller, and Kenneth G. Harstad of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 128*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

NPO-20066

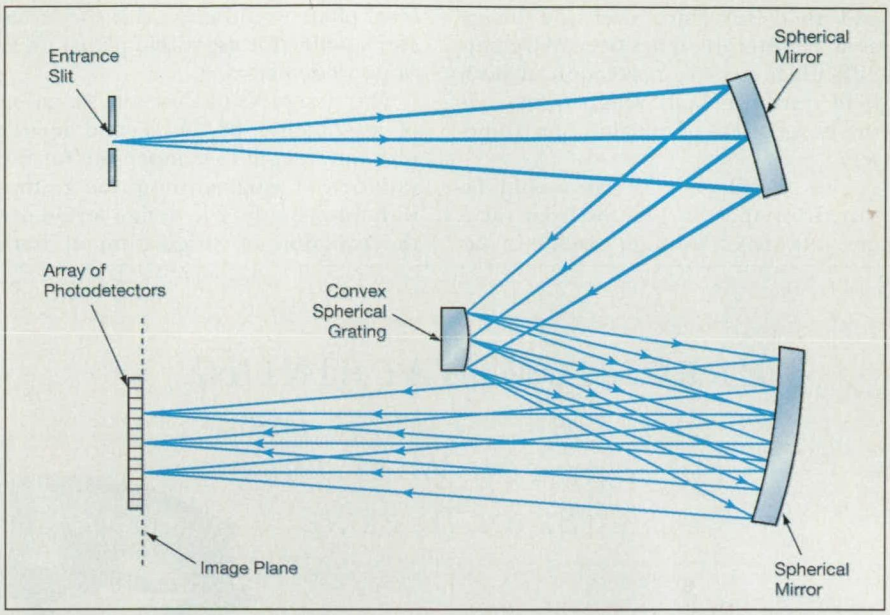
Convex-Grating Spectrometer With Two Spherical Mirrors

Compact, well-corrected optics would be suitable for imaging spectroscopy in commercial applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure shows the basic optical configuration of an improved all-reflecting imaging spectrometer. This spectrometer would differ from older spectrometers in several respects, one being its convex spherical diffraction grating: heretofore, spectrometers have contained, variously, concave or plane diffraction gratings. The specific design, featuring the convex grating and two concave spherical mirrors, would afford a wide field of view and a compact layout that would make the size of this spectrometer about 1/3 that of a spectrometer of typical older design and similar capabilities. The sphericity of the optical surfaces would make fabrication relatively easy and inexpensive.

The radii of curvature of the grating and mirrors and the off-axis positions and angles at which these optical components would be mounted have been selected to give the excellent spatial and spectral performance over the



The **Ray-Trace Diagram** illustrates the basic function of the convex-grating spectrometer. In this view, the long dimension of the entrance slit and thus the spatial axis of the image plane lie perpendicular to the page, while the spectral dispersion axis of the image plane lies on the dotted line in the page.

Real Time Solutions

Kevex X-Ray...*Microfocus Sources*

High Definition Radioscopic Images

Good things come in small packages. When it comes right down to it, you simply won't find better 160KV performance in a package as compact as the KM160. In addition to the space savings, you'll be pleasantly surprised with the ease of use and serviceability. The KM160 uses the newest advances in gas-insulated high voltage technology to deliver high performance and long-term reliability. And, you'll appreciate the economy that comes with the KM160, a performance-to-price ratio hard to beat. **Call today for details.**

High Resolution Radioscopy

KM160

Features
- High Brightness
- Continuous Duty
- Constant Potential
- Air-cooled

Principal Specifications
- 160KV, 160 Watt
- 8 Micron Spot
- 4 Spot Sizes
- 15mm Working Distance

Typical Applications
- Quality Control
- Electronic Inspection
- Computer Aided Tomography

Kevex X-Ray
SPECIALIZED X-RAY SOURCES

KEVEX X-RAY, INC. • 320 El Pueblo Road • Scotts Valley, CA 95066
Tel: 408-438-5940 • Fax: 408-438-5892

A ThermoSpectra Company

See us at:
www.kevex-x-ray.com

image plane. The spectrometer would produce a well-corrected, spectrally dispersed image of the entrance slit over a wide spectral range. The outstanding quality of the image would be attributable to good correction of astigmatism and field curvature over the image area. Heretofore, it has been extremely difficult to achieve correction of both field curvature and astigmatism over the image areas of imaging spectrometers.

The all-reflecting design would be suited for spectral regions from vacuum ultraviolet through visible to far infrared. Unlike in older imaging spectrometers, there would be no need for a field-flattening lens: this would constitute a major advantage for operation over extended spectral regions. The relative flatness of the focal plane would make this spectrometer suitable for use with a planar array of photodetectors.

The design would use the variation of astigmatism of the second mirror with wavelength to compensate for the variation of astigmatism of the grating with wavelength. The design would use the variation of astigmatism of both mirrors with field angle to compensate for the variation of astigmatism of the grating with field angle. The design would also use both spherical mirrors to compensate for the spectral and spatial field curvature intrinsic to the grating. Though the design does not look complicated, the process of optimizing the design was complicated because it involved careful selection of design parameters to balance astigmatism, field curvature, and coma over the spatial and spectral fields.

Design calculations show that in both the spectral and spatial aspects, the optical performance of this spectrometer would exceed that of any imaging spectrometer now in existence. Excellent spatial resolution perpendicular to the spectral dispersion axis would make this instrument attractive for a variety of industrial and medical applications that have already given rise to a multimillion-dollar market in imaging spectrometers.

This work was done by Michael P. Chrisp of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 125*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office–JPL; (818) 354-5179. Refer to NPO-19293.

PRECISION MACHINING

COMPLEX MULTI-FACETED PARTS
THE WAY YOU WANT THEM
. . . EXACT TO PRINT.

RIGID ADHERENCE TO SPECIFICATIONS
TOLERENCES TO ±0.000040"

PROTOTYPE TO PRODUCTION . . .
VERY SMALL TO LARGE PARTS
EXTENSIVE EXPERIENCE WITH
HIGH STRENGTH ALLOYS & TITANIUM

STATE-OF-THE-ART EQUIPMENT
8-AXIS SWISS, 5-AXIS MACHINING CENTERS,
LARGE TURNING WITH C&Y AXIS,
FULL C-AXIS CNC GRINDING

MIL-I-45208A, GMP, ISO 9002 &
ISO-10012-1
GOVERN MANUFACTURING SYSTEMS, PROCEDURES &
QUALITY CONTROL TO THE LEVEL OF ZERO DEFECT

OVER 90 YEARS OF EXPERIENCE AND EXCELLENCE
MANUFACTURING IN A MODERN 50,000 SQ FT FACILITY

FAST QUOTE ON YOUR PRINTS & SPECS . . .
E-MAIL lpi@lavezzi.com OR FAX 630-582-1238
RELY ON ACCURATE ESTIMATES & ASSISTANCE WITH
INNOVATIVE ENGINEERING SERVICES &
PRECISION MANUFACTURING

LAVEZZI

QUALITY . . . ABOVE ALL ELSE.

LaVezzi Precision, Inc. ■ 999 Regency Drive ■ Glendale Heights, IL 60139-2281
630-582-1230 ■ Fax: 630-582-1238 ■ E-mail: lpi@lavezzi.com ■ 800-323-1772

For More Information Circle No. 422

Weighted-Hyperbola Technique for Locating Pulsed Sources

John F. Kennedy Space Center, Florida

The weighted-hyperbola technique is an iterative computational technique for processing data on the times of arrival of pulsed signals at more than four observing stations to determine location (in both space and time) of origin of the signals. (The location is overdetermined when data from more than four stations are available). The

technique was developed especially for use in processing data on electric-field signals to locate lightning sources and is expected to be particularly beneficial in cases in which the sources are near the ground. On each iteration, a "best estimate" of the location of the source is computed as a weighted average of locations from all possible four-station combinations of readings. The weight for each spatial coordinate for each four-station combination is proportional to the reciprocal of the variance for that coordinate and four-station combination, where the variance is based on the previous best estimate.

This work was done by Ewen M. Thomson of the University of Florida for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 187*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Ewen M. Thomson
University of Florida
Dept. of Electrical Engineering
P.O. Box 116200
Gainesville, FL 32611

Refer to KSC-11861, volume and number of this NASA Tech Briefs *issue, and the page number.*

Silicon Heat Exchanger for Use at Low Temperatures

Narrow flow passages are fabricated to high precision by micromachining.

NASA's Jet Propulsion Laboratory, Pasadena, California

A heat exchanger made largely from pieces of single-crystal silicon has been designed for use as a recuperator in a reverse-Brayton-cycle cryocooler. Its design is optimized for transferring heat between counterflows of neon at a mass flow rate of 0.7 g/s, with an inlet temperature of 300 K and pressure of 2.21 atm (0.224 MPa) on the warm side and an inlet temperature of 60 K and pressure of 1.3 atm (0.13 MPa) on the cold side.

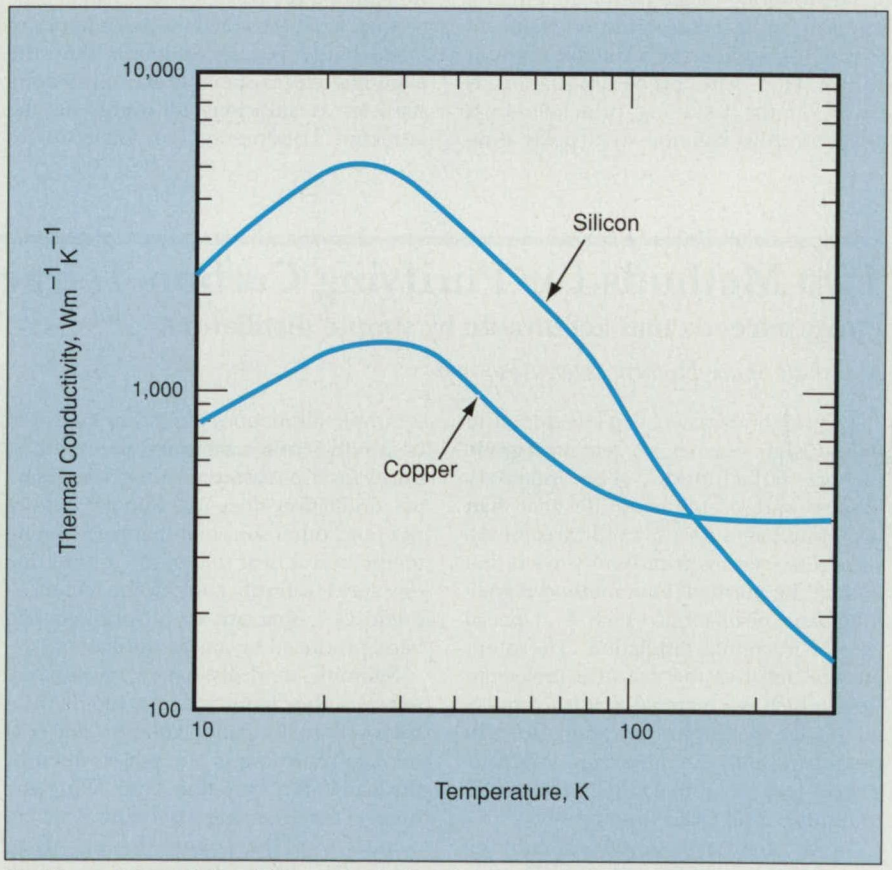
Ordinarily, one might be inclined to make a heat exchanger from a highly thermally conductive metallike copper. However, single-crystal silicon offers advantages over copper in this particular application. One advantage pertains to thermal conductivity. The thermal conductivity of single-crystal silicon ranges from less than that of copper at room temperature to greater than that of copper at cryogenic temperatures. Detailed heat-transfer calculations performed with known conductivity-vs.-temperature data (see figure) have shown that on balance, the superior low-temperature thermal conductivity of silicon prevails in the specific intended application. This makes it possible to obtain better heat-transfer performance in a heat exchanger of given size, shape, and complexity; or, alternatively, to obtain equivalent heat-transfer performance in a smaller and/or less complex heat exchanger.

Another advantage of silicon is that established technology for micromachining of single-crystal silicon by photolithography, etching, and related techniques is commercially available. Thus, silicon components with multiple narrow and/or short flow passages can readily be fabricated to obtain flow and thermal-conduction geometries that are defined with high precision to optimize heat-transfer performance.

Yet another advantage of silicon is that its mass density is only 2.33 g/cm^3, whereas that of copper is 8.92 g/cm^3. As a result, a silicon heat exchanger weighs about 74 percent less than does an identically sized and shaped copper heat exchanger for the intended operating temperatures.

This work was done by Thomas J. Jasinski and William E. Nutt of Creare, Inc., for **NASA's Jet Propulsion Laboratory.** *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, NASA Resident Office-JPL; (818) 354-5179. Refer to NPO-30021.



The **Thermal Conductivity of Silicon** exceeds that of copper in the lower part of the intended range of operating temperatures.

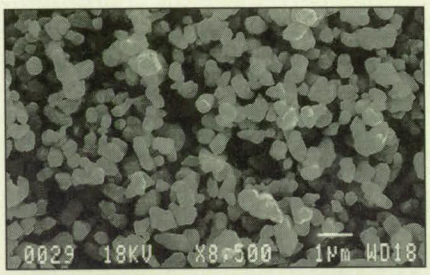
Alumina/Ethanol Colloidal Suspensions for Seeding Hot Flows

These suspensions are stabilized by adjustment of pH.

Lewis Research Center, Cleveland, Ohio

The alumina for making a suspension according to this concept must be in the form of a highly pure (preferably >99.99 percent) powder with a suitable particle-size distribution — preferably monodisperse with a mean particle size of a fraction of a micron, as illustrated in the figure. The alumina powder is mixed with an ethanol solution, the pH of which has been lowered to a predetermined value (typically between 1 and 5) as explained below. The amounts of alumina powder and ethanol solution are chosen to obtain the desired concentration of solid material in the suspension. Optionally, the suspension can be made initially in a high concentration (e.g., 20 weight percent alumina), then diluted. During mixing or dilution, the liquid and solid contents are agitated with an ultrasound to break up agglomerations of particles.

The lowering of the pH of the ethanol solution to a predetermined value is effected by addition of a suitable amount of 1N HCl. The predetermination is based on the following principle: In a polar aqueous solution or a polar non-aqueous liquid like ethanol, the surfaces of the particles become electrically charged by amounts that depend on the pH, among other factors. The stability of the suspension depends on the sign and magnitude of the total energy of interaction among the particles. One can choose a value of pH for which the amount of surface charge is large enough that the resulting electrostatic repulsion among particles is sufficient to overcome the attractive London-van der Waals forces that cause agglomeration. Thus, the chosen pH should be far from that value of pH (called "pH_{pzc}"for which the surface charge is zero). In general, different grades of alumina powder and alumina powders from different manufacturers exhibit different values of pH_{pzc}. The pH_{pzc} of the powder to be used in a specific application must be determined precisely by titration or approximately via sedimentation tests.



This **Scanning Electron Micrograph** shows particles of alumina powder with a mean particle size of 0.7 ± 0.2 μm. Most of the particles are roughly spherical and small enough to be suitable for use in seeding flows.

This work was done by Mark P. Wernet of **Lewis Research Center,** *Gary J. Skoch of the Vehicle Technology Center of the U. S. Army Research Laboratory, and Judith H. Wernet of Case Western Reserve University. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 143*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16423.

Two Methods for Purifying Carbon Tetrachloride

Purity exceeds that achievable by simple distillation.

Marshall Space Flight Center, Alabama

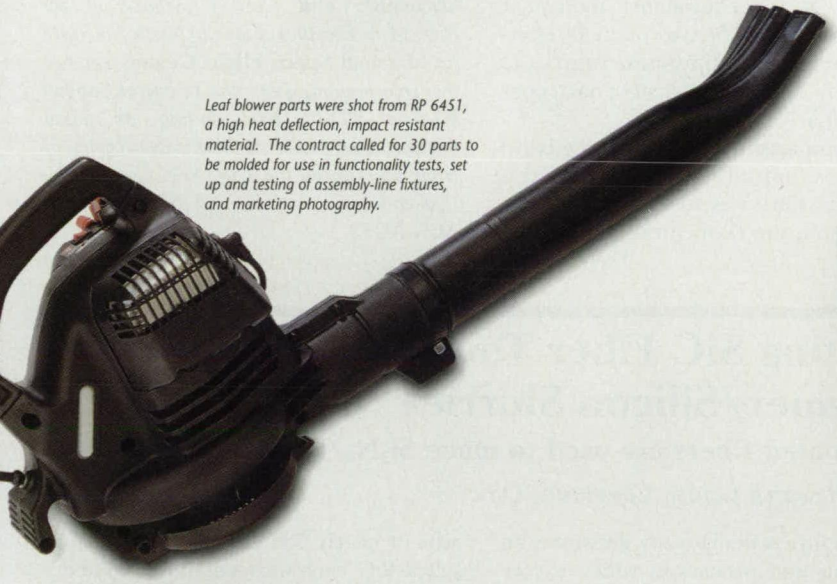
Two methods have been developed to purify large batches of technical-grade carbon tetrachloride. The relatively impure carbon tetrachloride that had been purchased for use in infrared analysis of dissolved hydrocarbons proved that it could be purified. One method is spinning-band distillation, which is a special type of fractional distillation. The other method involves the use of a molecular sieve, which is a material that is formulated to have special porosity and adsorbent properties and can physically lock substances (e.g., the impurities that one seeks to remove from CCl_4) into its pores.

To be useful as a solvent for infrared analysis, CCl_4 must be very pure. The two methods were investigated as alternatives to simple distillation, which was known to be insufficient for achieving the required purity for two reasons: (1) in general, simple distillation does not remove impurities (e.g., other solvents) that have boiling temperatures near that of the solvent that one seeks to purify and (2) the technical-grade CCl_4 that was to be purified had been produced by simple distillation.

Spinning-band distillation involves the use of a thin band rotating rapidly in a narrow-bore distillation column. The condensate returning to the pot is wiped by the band in a very thin layer along the bore. The returning condensate makes contact with the counterflowing, rising vapors. The net result, in comparison with that achievable by simple distillation, is better separation of constituents with higher boiling temperatures from constituents with lower boiling temperatures. The improvement in separation is attributable to enrichment of the vapor in the more volatile constituents.

Although the spinning-band distillation method was effective, it was decided that an attempt should be made to develop a faster and perhaps even more effective method. Gas chromatography coupled with mass spectrometry (GC-MS) and infrared spectrometry had indicated that most, if not all, of the impurities were polar molecules. So it was decided to try to develop a method that would preferentially remove polar molecules from this nonpolar solvent (CCl_4). It was reasoned

Blood centrifuge covers were produced from RP 6453, chosen for its high heat deflection temperature, good impact resistance and flame retardance. Nearly 1,500 covers were molded in 12 months for installation on centrifuges shipped throughout the world.*



Leaf blower parts were shot from RP 6451, a high heat deflection, impact resistant material. The contract called for 30 parts to be molded for use in functionality tests, set up and testing of assembly-line fixtures, and marketing photography.

Forty 20-lb. automotive bumper fascias were cast from RP 6450, a dimensionally stable, impact-resistant polyurethane with properties similar to the RIM material being used for the end-parts. Prototypes were built for fit-and-function analysis and air-flow testing.

Real Parts. Real Fast.

Parts In Minutes™ Polyurethanes for prototypes...and beyond.

With Parts In Minutes™ Polyurethanes you can produce close-tolerance prototypes, as well as durable end-use plastic parts, in as little as ten minutes. Quick gel and demold times help to optimize product-to-market lead times.

Parts In Minutes™ Polyurethanes give you the freedom to select a material with the appearance and performance characteristics to meet each job's specific requirements. Choose from 11 different products with properties such as high impact strength, high heat resistance, flame retardance* and high flexural modulus to match the prototyping material to the end-use thermoplastic—ABS, polypropylene or polyethylene.

The Parts In Minutes™ Polyurethane line is backed by our "Value Beyond Chemistry" commitment to customers — with worldwide technical support offered by a staff experienced in rapid prototyping/rapid manufacturing techniques and materials.

Learn more about Parts In Minutes™ Polyurethanes by calling for our Selector Guide and/or demo video.

* *@0.125 inches*

To find out how Parts In Minutes™ Polyurethanes can help you meet customer requirements, contact:

ISO 9001 Certified

Ciba Specialty Chemicals

Performance Polymers

Adhesives & Tooling

4917 Dawn Avenue
East Lansing, MI 48823
Tel: 800-367-8793
Fax: 517-351-6255

Duxford, Cambridge
CB2 4QA England
Tel: 44-1223-832121
Fax: 44-1223-493219

Ciba

Value beyond chemistry

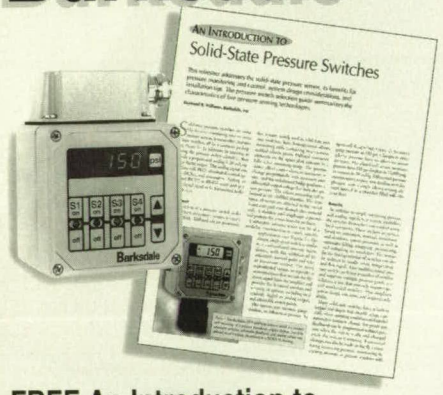
Barksdale

NEMA 4 Watertight Compact Pressure Switches

Innovations are expected from Barksdale, the world's leader in pressure switch design and production. This is the popular 96200 Compact Series, fitted with conduit connections for watertight NEMA 4 protection. Choose from field adjustable and factory preset models with operating pressure ranges of vacuum to 7,500 psig. Switching capacity is up to 10 amps at 125/250 VAC. The 96200 Series switches measure only 4-1/2" long by 1-1/4" in diameter. For a ***free catalog***, contact Barksdale, Inc., (800) 835-1060 FAX (213) 589-3463.

Circle 408

Barksdale



FREE An Introduction to Solid-State Pressure Switches

This all new technical article reprint provides the reader with a detailed review of solid-sate pressure switches and their benefits for pressure monitoring and control. A comprehensive selection guide outlines the characteristics of the five basic pressure sensing technologies, covering, among other things, life cycle, operating range, proof pressure and relative price range. Call or write for your free copy today. (800) 835-1060.

Circle 409

www.barksdale.com

CRANE® **Barksdale, Inc.** A SUBSIDIARY OF CRANE CO. ISO 9001

that molecular sieves might be able to achieve such preferential adsorption. Several were tried and one was found that adsorbed the impurities as desired.

In this method, an activated molecular sieve is immersed in the solvent in a glass container. Optionally, one can stir the solvent to bring more of the solvent into contact with the molecular sieve within a given time and thereby accelerate the purification process. By experimentation with several different molecular sieves, the Linde 13X (or equivalent) molecular sieve was found to be exceptionally effective in removing impurities from CCl_4. The Linde 13X molecular sieve has a pore size of 10 Å.

In comparison with spinning-band distillation, purification by use of this molecular sieve was found to be faster. In addition, the concentration of impurities (1 part per million) remaining after contact with the molecular sieve was found to be less than that remaining after spinning-band distillation. Yet another advantage of the molecular sieve is that it can be regenerated and reused. Recent advances in the synthesis of molecular sieves suggest that it may be possible to tailor the pores and/or constituents of a molecular sieve to remove selected impurities from a liquid.

This work was done by Raymund P. Skowronski and Carl J. Schack of the Rocketdyne Division of Boeing North American for **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 166*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
MFS-30132

Coating SiC Fiber Tows With Polymer/Silicon Slurries

The coated fibers are used to make Si_3N_4/SiC composites.

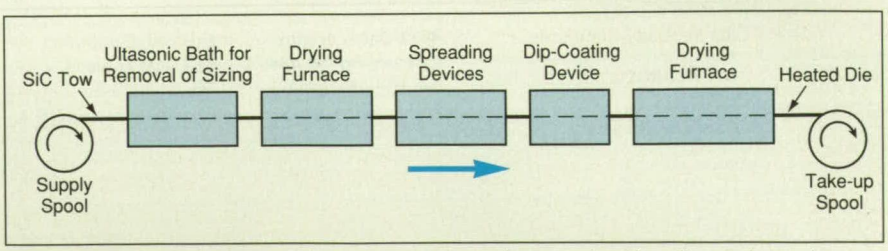
Lewis Research Center, Cleveland, Ohio

The figure schematically illustrates an apparatus and process in which a continuous tow of silicon carbide fibers is coated and infiltrated with a polymer/silicon slurry. A compact of such coated, infiltrated fiber tows is subsequently heated to a temperature ≥ 1,200 °C in nitrogen to convert it to one of a variety of materials, denoted generally as "SiC/RBSN," that are composites of silicon carbide fibers in reaction-bonded silicon nitride matrices. SiC/RBSN composites are candidates for use in structural components for some high-temperature applications.

A slurry of the type used in this process consists of silicon particles with a mean diameter of 0.3 μm suspended in an isopropyl solution of a polymeric binder. The use of submicron silicon particles and the choice of proportions of the other ingredients to achieve low viscosity of the slurry are necessary to ensure infiltration of the slurry into the interstices of the tow. A fiber tow of the type used in this process typically consists of nearly 500 filaments of ceramic-grade SiC, each with a diameter of about 15 μm. The fibers as manufactured are coated with a sizing of polyvinylacetate, which must be removed in the process to make room for infiltration by the silicon particles.

The tow is drawn from a supply spool, through the apparatus and process, to a takeup spool. After coming off the supply spool, the tow first passes through a few cylinders that contain solutions of equal volume proportions of isopropyl alcohol and water. The solutions are heated to a temperature between 35 and 55 °C and agitated ultrasonically. The sizing would ordinarily be insoluble in static isopropyl alcohol/water solutions, but with the ultrasonic agitation, the solutions gradually dissolve the sizing.

After emerging wet from the last sizing-removal bath, the tow is drawn through a drying furnace. The dried tow passes into a spreading device, wherein air is blown across the tow, creating vibrations and spreading the fibers out.



A Tow of SiC Filaments is Drawn through an apparatus that coats it with a silicon/polymer slurry.

In addition, an electrostatic generator puts electrostatic charges on the passing fibers, so that mutual electrostatic repulsion will enhance spreading.

The spread tow is plunged into a dip-coating device, where it is coated and infiltrated with the slurry. The coated, infiltrated tow then passes through a second drying furnace. As the tow emerges from the furnace, it is consolidated by drawing it through a heated circular die. Typical drying and die temperatures range from 110 to 190 °C.

This work was done by Rickmond C. Chan of **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category, or* ***circle no. 165*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16516.

Nitrogen-Beam Source for Deposition of III/V Nitrides

This apparatus improves the synthesis of wide-band-gap nitrides.

Marshall Space Flight Center, Alabama

A nitrogen-beam source has been developed to significantly improve the synthesis of wide-band-gap nitrides.

In experiments supported by the Department of Defense and NASA, thin nitride films have been grown by use of a unique neutralizer for atomic-beam source (NABS). The NABS is a simple device – a hollow metal cone. When the NABS is attached to a broad-beam ion source that emits dinitrogen ions, these ions become neutralized, focused, and dissociated through collisions on the inside conical surface.

Although it is extremely simple to construct, this device made it possible to grow some of the first thin films of cubic boron nitride. The NABS was subsequently used in creating buffer gallium nitride layer structures on which high-mobility thin films of gallium nitride were grown by use of an electron cyclotron resonance source.

The potential use of an ion source with a high flux of atomic neutral species from an end-Hall system could be very important to the growth of compounds of (1) nitrogen and other elements from period V and (2) elements from period III of the periodic table. The promising initial growths in the boron nitride system indicate that these materials may be better suited to ion-beam deposition methods and less sensitive to damage than when grown by conventional (non-ion-beam) deposition methods.

This work was done by J. Albert Schultz, of Ionwerks, for **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 154*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

MFS-26464

Computer Software

Software for Retrieval and Display of Planetary Data

The NASAView computer program provides access to, and display of, sets of scientific data in the Planetary Data System (PDS) archive. These data—totalling about 5 terabytes — were acquired during NASA's planetary-exploration missions and are stored along with descriptive information useful for retrieving and interpreting the data. NASAView is designed to be usable on multiple platforms (including Sun/UNIX, Apple Power PC, and PC/Win32 computers and operating systems). NASAView converts between machine-specific data representations as necessary and provides graphical user interfaces (GUIs) with a common look and feel on all the platforms. NASAView incorporates the PDS Label Library Light (L^3) and the PDS Object Access Library (OAL), which are the standard software libraries for production and use of the PDS archive. The L^3 reads and parses a data-product label and provides access to label information by use of standard function calls. Using the label information, the OAL manipulates the scientific data at the physical-record, data-representation, and object (data-product-as-a-whole) layers. NASAView also incorporates the XVT Portability Toolkit™ software, which provides the capabilities for development and use of the common GUIs on different platforms and ensures the same application functionality on the various platforms.

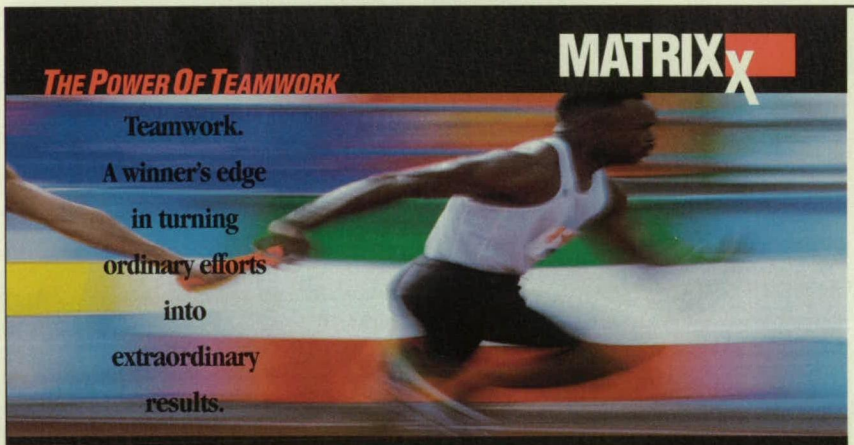
This program was written by John S. Hughes and Michael D. Martin of Caltech, Luke T. Fu of MIT, and Todd King of UCLA for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 137*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

NPO-19795

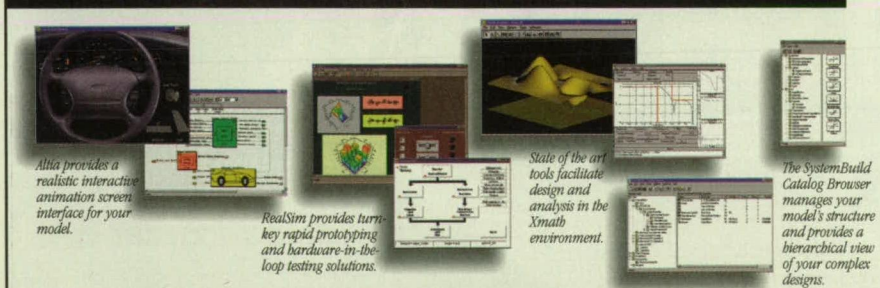
COSMIC, NASA's Software Technology Transfer Center, has an inventory of over 800 software packages that originally were developed by NASA and its contractors for the U.S. space program. These packages have a wide range of applications other than space exploration and are used by industry, academic institutions, and other government agencies.

For further information about software available from COSMIC, or to receive a free diskette catalog, contact COSMIC at:

COSMIC
The University of Georgia
382 East Broad Street
Athens, GA 30602-4272
Phone: 706-542-3265
Fax: 706-542-4807
e-mail: service@cosmic.uga.edu
WWW: http://www.cosmic.uga.edu



The MATRIX$_X$ Team provides complete and flexible functionality for the entire life-cycle of your real-time embedded software system development.



© 1998 Integrated Systems, Inc. MATRIX$_X$ is a registered trademark of Integrated Systems, Inc.

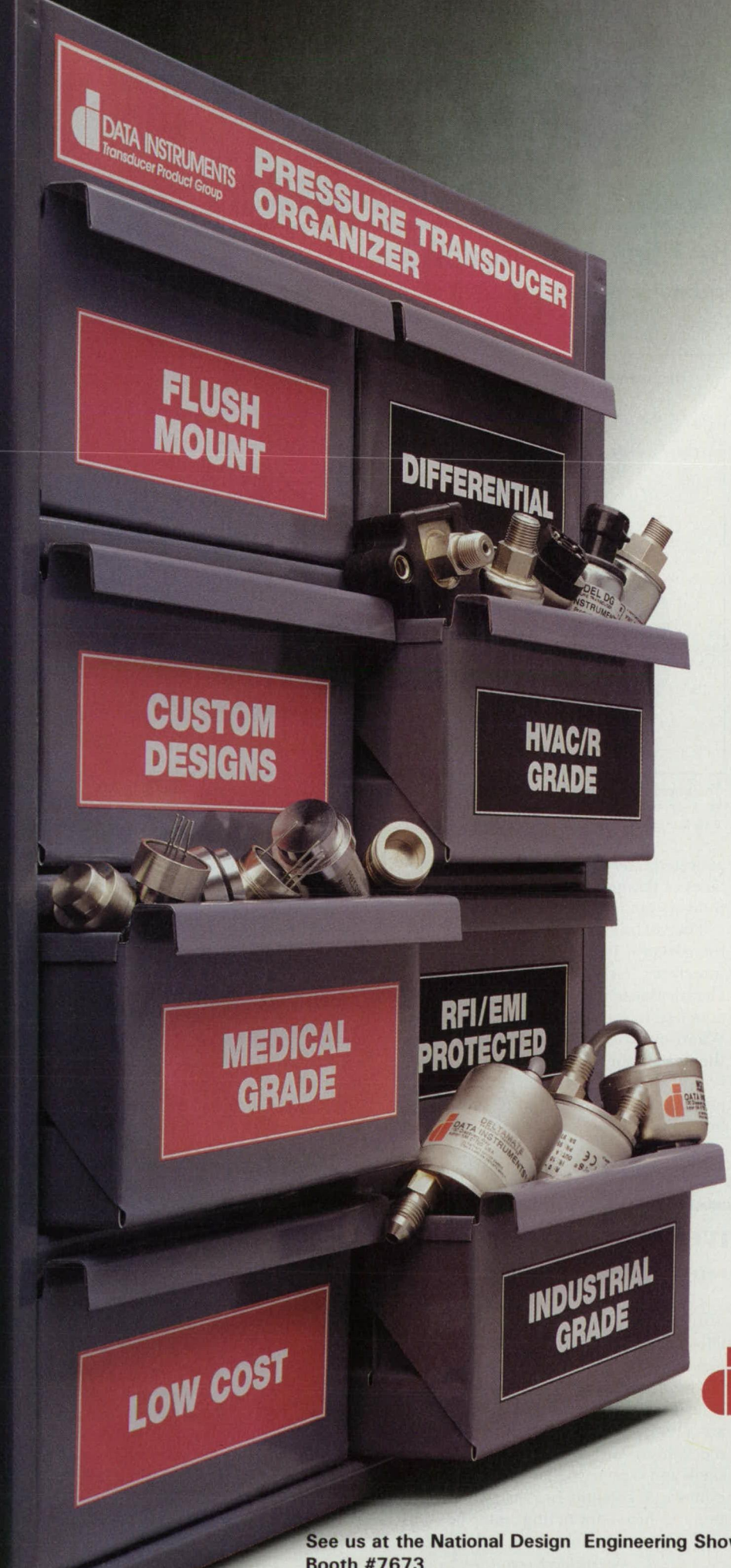
Whether your team is sprinting to deliver a simple product enhancement, or running to introduce a major new product line, efficient handoff between design centers is critical to the success of your engineering project.

MATRIX$_X$ engineering productivity tools let you simulate the "finish line" through its unique "design via simulation" environment. With a single source for analysis and simulation, and automatic code and document generation, MATRIX$_X$ helps reduce code errors and design rework. And thanks to its open architecture framework, MATRIX$_X$ is easily integrated into your design process, while leveraging your existing design investment. MATRIX$_X$ - including Xmath, SystemBuild, AutoCode, RealSim and DocumentIt - will quickly become your team's most valuable tool, helping you to deliver on schedule and within budget. To give you that extra edge, your MATRIX$_X$ Team includes our experts at Integrated Systems. Complete with a technical support hotline, product training and on-site technical support, Integrated Systems is there for you every step of the race.

integrated systems

800.770.3338
www.isi.com

Booth 611 ESC-East



Selecting Pressure Transducers?

We make it easy.

Whether you're looking for standard transducers or need a custom design, look into Data Instruments. Draw on over thirty years of experience and an endless selection of pressure transducers to meet your specific needs.

With millions of pressure sensors in use worldwide, you can be assured of:

- **Quality** – "Ship to stock" approval and ISO 9000 certification ensures trouble-free operation.
- **Reliability** – Robust "SEMS" design and stainless steel packaging gives you years of maintenance-free operation.
- **Performance** – Unique, patented "SEMS" design guarantees high accuracy and stability.

Our transducers have been proven, time and time again, in real-world applications. Let us put some to work for you.

To speak with a Data Instruments technical expert, or for a free copy of our catalog, call us now!

For More Information Circle No. 504

DATA INSTRUMENTS
Transducer Product Group

100 Discovery Way, Acton, MA 01720-3648
1-800-333-DATA (3282)
Fax: (978) 263-0630
http://www.datainstruments.com

See us at the National Design Engineering Show, Booth #7673

Metal Gasket Bonded by Electrical Heating

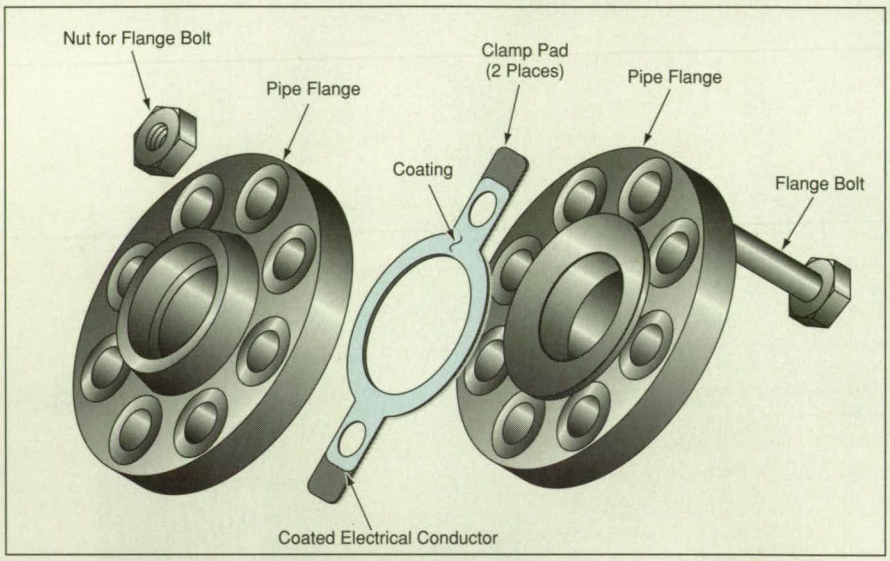
A weld-quality seal can be made without welding.

Marshall Space Flight Center, Alabama

An improved technique for sealing a joint in a fluid system involves the installation of a specially designed gasket in a thermal bonding process. The process results in a leak-free joint. Heretofore, joints have been sealed, variously, by welding and by such mechanical means as lapping and the use of gaskets. It has been extremely difficult to make leak-free joints by mechanical means.

With respect to protection against leakage, sealing by the present improved technique is equivalent to welding. However, unlike in welding, there is no need for a certified welder or for full access to the joint to be sealed. The time and cost of assembling and sealing a joint by the present technique is less than the process time and cost of welding a comparable joint. The present improved sealing technique and gasket design make it possible to achieve tight seals, without need for lapping, between flanges and flat-faced coupling surfaces in fluid systems. This type of sealing technique is also a candidate for replacing currently used engine cylinder head gaskets.

The basic component used in the present technique is a flat, electrically conductive gasket, usually with a hole in the center. The gasket comprises an electrically conductive substrate coated on both sides with a low-melting-temperature metallic alloy. When properly activated, the gasket bonds to the surfaces of flanges or other surfaces of the fluid-system joint to be sealed.



The **Improved Sealing Technique Has Gaskets and Flanges** that are assembled and clamped together. Then the gasket is heated by passing electrical current through its substrate to melt the coating and thereby form bonds with the flanges.

The sealing process is simple. Once the gasket is inserted between the joint interfaces (see figure) and secured, electrical leads from a power source are attached to opposite ends of the gasket. When electrical energy is supplied via the leads, the coating melts, creating bonds at the interfaces. To unseal the joint, one simply removes the flange bolts and reheats the gasket.

This work was done by Melvin A. Bryant III of **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 153*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (205) 544-0021. Refer to MFS-31175.

Vertical Centrifugal Investment-Casting Machine

Improved design increases the strength of investment castings.

Marshall Space Flight Center, Alabama

The need for improved investment castings at Marshall Space Flight Center's Rapid Prototyping Lab has led to the development of a simple machine for centrifugal investment casting of shells. This machine spins a radially symmetric shell about its own axis in a vertical orientation. This rotational process increases the strength of the investment casting by allowing the metal to move into even the most obscure crevices of the shell.

The major components of the vertical centrifugal investment-casting machine are a funnel, a turntable with a clamping mechanism, an electric motor, exterior shells and supports, a base plate, two semicylindrical ceramic heaters with insulation, a heat-conducting interior drip shield, and a heater-control device with feedback from a thermocouple. Although not part of the machine, a digital stroboscope and an accelerometer with a temperature-compensation and signal-amplification circuit are used during the vertical centrifugal investment-casting process.

The process of investment casting is not new. However, risers of novel designs were

Let Microway build your next Graphics Workstation, Personal Supercomputer or Server using...

Screamer™ 600

Cray Performance at a PC Price!

600 MHz Alpha, 1.2 Gigaflops, 4MB Cache

Since 1982 Microway has provided the PC world with the fastest numeric devices and software available. No product in the last 15 years has excited us more than the Alpha Screamer. With its ability to execute 2 billion operations per second, the Screamer is the best choice for your next workstation or server! In addition to NT, the Screamer runs Digital UNIX and Linux.

Your applications can now run on "the fastest Windows NT machine on the planet." These include Microsoft Office, Oracle and Netscape; plus engineering and graphics software such as Pro/Engineer, Fortran, C/C++, Visual Basic, Microstation, ANSYS, LAPACK, Gaussian, Softimage and Lightwave. Over the last 15 years we have designed systems for thousands of satisfied customers worldwide, including prestigious institutions like NASA and Fidelity Investments. Our technicians are expert at configuring all Alpha operating systems and applications, and you will not find more technically competent sales people anywhere.

Custom Screamer Workstations

Microway systems include fast CPUs with equally fast caches, up to 2GB of high-speed memory and peripherals including SCSI hard drives, 3D graphics cards and RAID solutions. Microway's exclusive 4MB SSRAM cache, fed by a 144-bit wide memory system, boosts performance by up to 100%. Screamer™ workstations range in price from $1,895 to over $30,000.

Microway produces one of the finest numeric optimized compilers - NDP Fortran. Since 1986, hundreds of applications have been ported to the X86 with it. Using hand-coded BLA's and FFT's, our new NDP VDSP Alpha Library hits 343 megaflops triangularizing dense arrays and performs a 1024 complex FFT in 200 microseconds. This library also includes LAPACK.

AlphaPowered™

Press Accolades for Microway's Screamer

Windows Sources - February, 1998
"the Microway system blew away the best Intel-based workstations we've tested. . .on our number-crunching Lightwave 3D test."

LINUX Journal - January, 1998
"Literally everything runs profoundly faster on the Screamer."

PC Computing - July, 1997 ★ ★ ★ ★
Microway's Screamer . . . "is, quite simply, the fastest Windows NT machine on the planet. . . The performance leader."

Desktop Engineering - September, 1997 *Product of the Month*

Computers in Physics - September, 1997 *Product of the Month*

Visit **www.microway.com** for complete product information or call technical sales at **508-746-7341.**

Digital, Alpha, and Digital UNIX TM Digital.
Visual Basic, NT, Excel and Word TM Microsoft.
Screamer, NDP Fortran and Microway TM Microway.

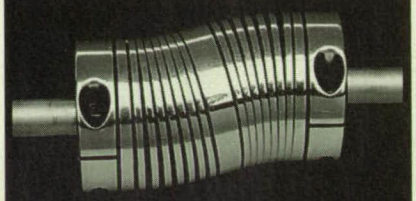
Microway®

Technology You Can Count On

Corporate Headquarters: Research Park, Box 79, Kingston, MA 02364 USA • TEL 508-746-7341 • FAX 508-746-4678
www.microway.com, info@microway.com • Denmark 45 39624156 • Germany 49 6997650001 • India 91 806637770
Italy 39 290782776 • Japan 81 64593113 • Korea 82 25561257 • Poland 48 22487172 • Spain 34 35809444 • UK 44 1819446222

For More Information Circle No. 509

Pick Your Solution



Couplings

Precision springs

U-joints

The HELI-CAL® Flexure, in the format of a coupling, u-joint or precision spring, can be designed and manufactured into a wide variety of shapes & sizes that enable it to be used for almost any application.

There are countless ways the HELI-CAL® Flexure can enhance your design... weight, space savings, multiple functions, special features, integrated attachments etc.

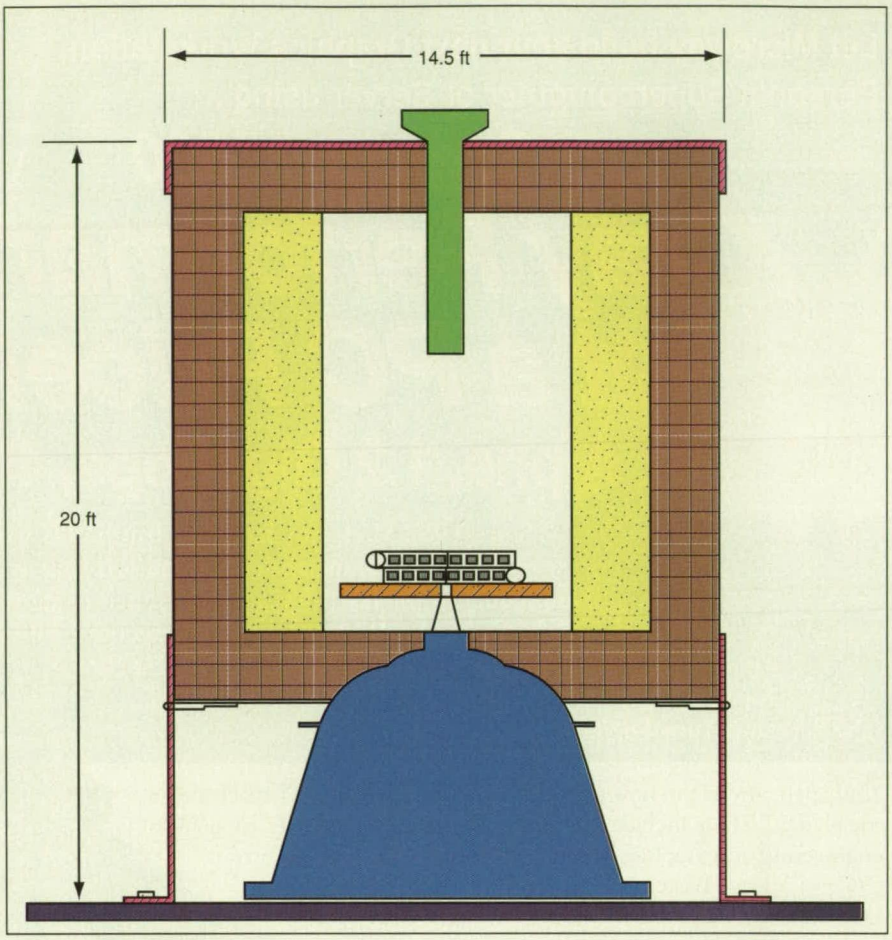
Contact us for a free catalog, sample, or more info !

HELICAL
PRODUCTS COMPANY, INC.

901 W.McCoy Lane, P.O.Box 1069,
Santa Maria, CA 93456-1069
tel 805-928-3851 fax 805-928-2369
www.Heli-Cal.com

See us at The National Design Show, Booth #8713

For More Information Circle No. 426



The **Vertical Centrifugal Investment Casting Machine** spins an axis symmetric shell about its own axis in a vertical orientation.

included in the vertical centrifugal investment-casting machine to accommodate dynamics of fluids in a rotational environment. For example, risers used in static casting are usually made funnel-shaped to assist foundry workers during metal-pouring processes. But a funnel-shaped riser increases the tendency for accelerated fluid to escape from the opening of the rotating shell. Therefore, for experiments conducted in the design of this machine, inverted funnel-shaped risers were attached to each shell. These inverted funnel-shaped risers provided back pressure to the spinning molten metal. The widest conical portions of the funnel-shaped risers also served as reservoirs for molten metal that escaped from a shell-molding cavity during centrifugal investment casting.

The process of dipping a wax pattern in a ceramic slurry and then applying a sand coat creates a shell with slight imbalances. When such a shell is rotated at high speed, these small imbalances can lead to significant vibrations and, consequently, a poor casting. The vibrations can also be hazardous.

To restore the center of gravity to the axis of rotation and thereby correct for these imbalances, a counterweight is put on the turntable. Holes around the perimeter of the turntable enable for the attachment of counterweights. For each shell being cast, it is necessary to test for vibrations, using a hand-held stroboscope, in order to determine the exact masses and locations of counterweights and the optimum rate of rotation.

Once the shell is properly balanced, the ceramic heaters and exterior shells are secured to the base plate. The shell is preheated, using a thermocouple to provide a temperature reading. Next, the heaters are turned off and the thermocouple removed. Rotation is begun immediately. Molten metal is poured into the funnel once full speed is reached. Within only a few seconds, the metal has been poured into the shell-molding cavity. After cooling, the machine is dismantled and the shell is extracted.

This work was done by Gary Lai and Floyd Roberts of **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 189*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (205) 544-0021. Refer to MFS-31181.

The All New Dash 8 Field Recorder From Astro-Med...

Big COLOR Monitor! Big Memory!

Small Package!

When signal exceeds pre-set limits, waveform automatically changes color.

- 10.4 Inch Active Color LCD Monitor – Color Code Each Waveform for Quick Analysis
- 2 GB Internal Hard Drive & 100 MB Zip® Drive
- 8 Channels – 2 kHz Response
- Isolated Input Range – 50 mV to 500 V FS
- DSP for Filtering, RMS, Integration, and Derivative
- Handy Z-Fold Chart
- Rugged, Compact, Portable – Less than 20 lbs

Look at data in real time on the color monitor and chart or record data to the big internal hard drive for playback and review later on the big, bright color monitor. Or, transfer data to the built-in removable Zip drive and use your computer for further analysis or archiving. The *all new* Dash 8 – truly a remarkable recorder and data acquisition instrument you can take anywhere.

Call, E-mail, Fax, or write to us today for all the details.

Astro-Med, Inc.

Astro-Med Industrial Park, West Warwick, Rhode Island 02893
Telephone: (401) 828-4000 • Toll Free: 800-343-4039 • Fax: (401) 822-2430
In Canada Telephone Toll Free: 1-800-565-2216
E-mail: astro-med@astro-med.com • **Web Site:** www.astro-med.com

Sales and Service Centers throughout the U.S., Canada and Europe.
Dealers located throughout the world • Astro-Med is System Certified to ISO 9001

For More Information Circle No. 560

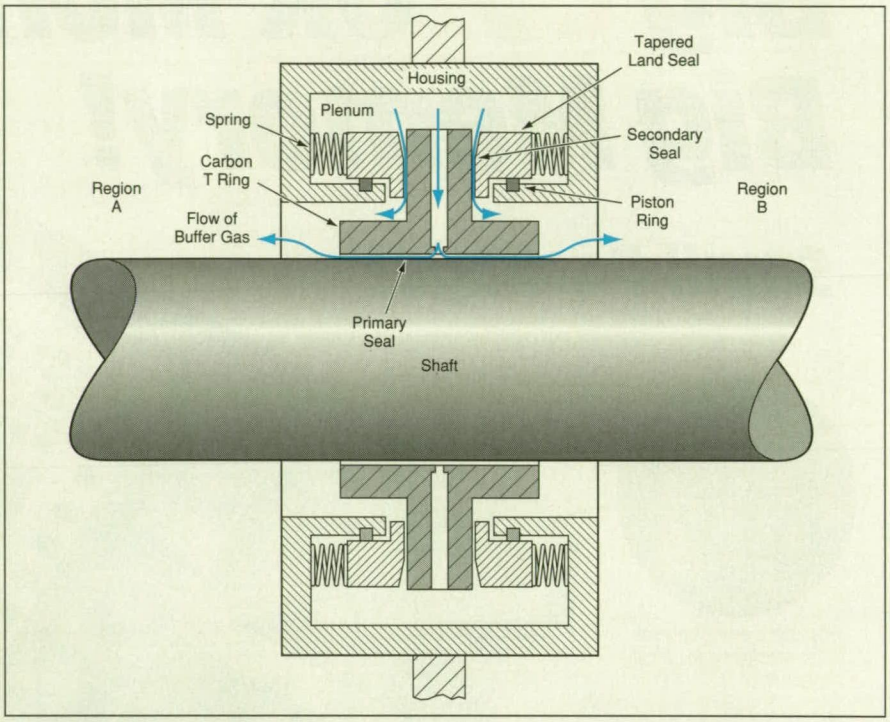
Gas Buffer Seal

The buffer flow separates two gases that must not come into contact.

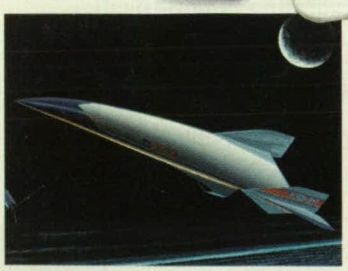
Lewis Research Center, Cleveland, Ohio

The figure presents a simplified view of a shaft seal that provides a small flow of neutral buffer gas to prevent contact between different gases contained in two adjacent regions along the shaft. In the original application, the shaft couples a hydrogen-burning turbine with a high-pressure oxygen pump, and helium is used as the buffer gas to prevent hydrogen/oxygen contact along the shaft. Other potential applications could involve the use of helium or other buffer gases or liquids to prevent mixing of fluids or to prevent escape of process fluids that are poisonous, odorous, or harmful to equipment or to the environment.

The seal (see figure) is a combination of a primary and a secondary seal. The main structural component of the seal is a solid carbon ring with a T-shaped meridional cross section. The buffer gas flows from a plenum, through 36 equally circumferentially spaced narrow radial holes in the ring, to the clearance [a gap 2 to 3 mils (0.05 to 0.08 mm) thick] between the ring



The **Leakage Flows of Buffer Gas in Narrow Clearances** act as low-friction seals and maintain the required separation between different gases in regions A and B.



100,000 feet, Mach 14, alternating extremes in temperature, high vibration, chemical exposure...Just another work day for TA elastomer products.

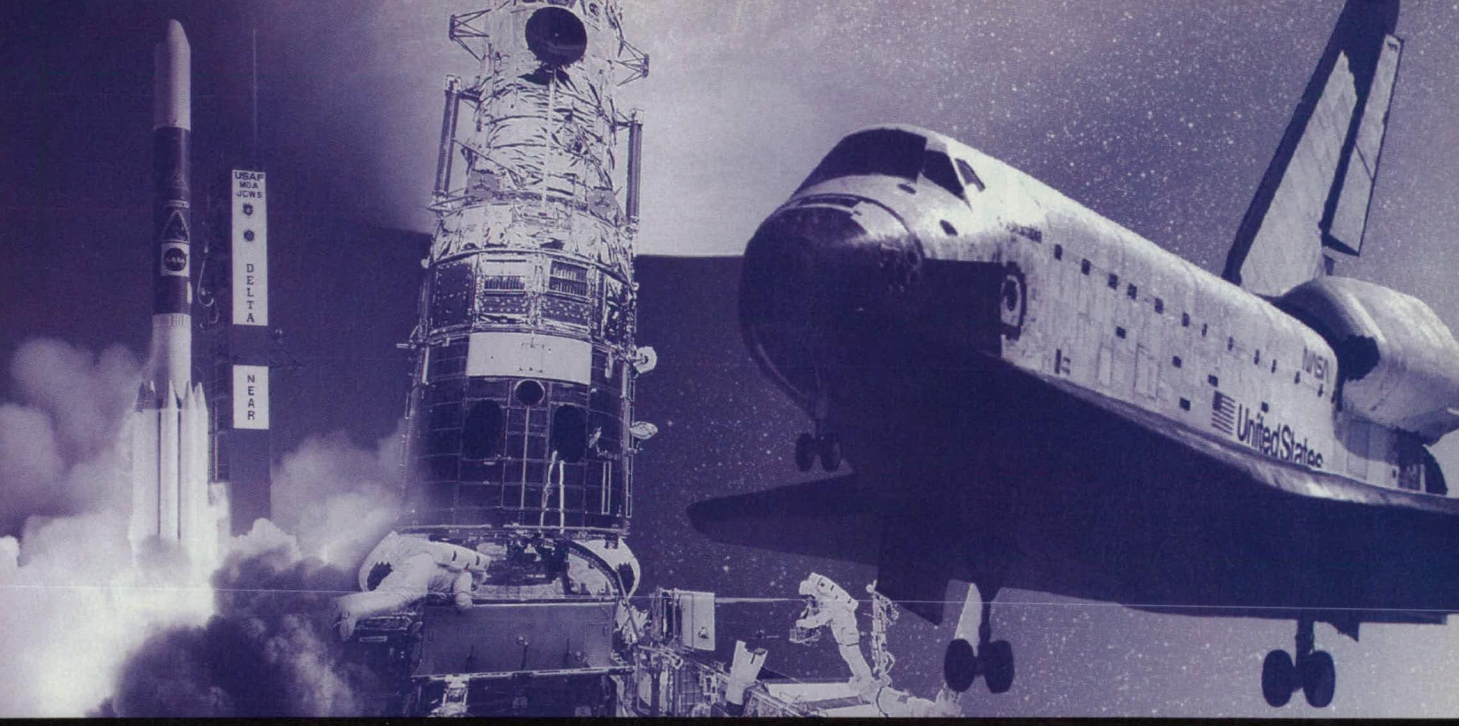
It's true, customers have come up with some really severe environmental challenges for TA's elastomer product design and manufacturing team. In response, TA has produced fabric - reinforced, stamped metal/elastomer, plastic/elastomer and precision tolerance components that have met the test and delivered added value over the life of programs.

TA provides complete and reliable program support including custom material formulations,design, engineering, prototyping and manufacturing. TA provides both standard and custom designs to meet your application. When your requirements call for an elastomer solution resistant to chemicals, vibration, mechanical loads or extreme temperatures, call TA early in the product design cycle.

Esterline TA MFG.

375 West Arden Ave., Glendale, CA. 91209-2500
Phone: (818) 240-4600 • Fax: (818) 241-3948
Aerospace and Defense Group.
Esterline Technologies

NOW ISO 9001 CERTIFIED



Get ready to launch your space projects faster than ever before.

Space-qualified converters.

Out-of-this-world reliability.

Power Converters	
SMHF	**SMSA**
15 watts	5 watts
Outputs: 3.3, 5, 12, ±12, or ±15 VDC	Outputs: 5, 12, 15, ±12, or ±15 VDC
Complete protection features	
Input voltage range: 16-40	

EMI Filter

SFMC

Meets MIL-STD-461C requirements

QUALIFIED FACILITY
CLASS K
MIL-PRF-38534

Interpoint's new fully qualified, radiation hardened DC/DC power converters and EMI filters deliver the performance of custom products.

They're the first space-qualified power products of their kind. And they're ready to go when you are, eliminating the time and expense of custom power solutions.

Models with up to 15 watts of output power delivered in a galaxy of configurations meet your every system need. Products are available in three different environmental screening grades with three different radiation tolerance options.

Concerned about quality? Don't be. Our new space power products are compliant to MIL-PRF-38534 Class K requirements. Screened models are guaranteed to withstand up to 100 k Rads (Si) and survive SEUs. And they're designed with the small size and light weight that space applications demand.

Need the best of both worlds? Then call us for out-of-this-world power products at down-to-earth pricing.

Call: 1-800-822-8782
(For your free poster)

Visit our Web site:
www.interpoint.com/tba

CRANE

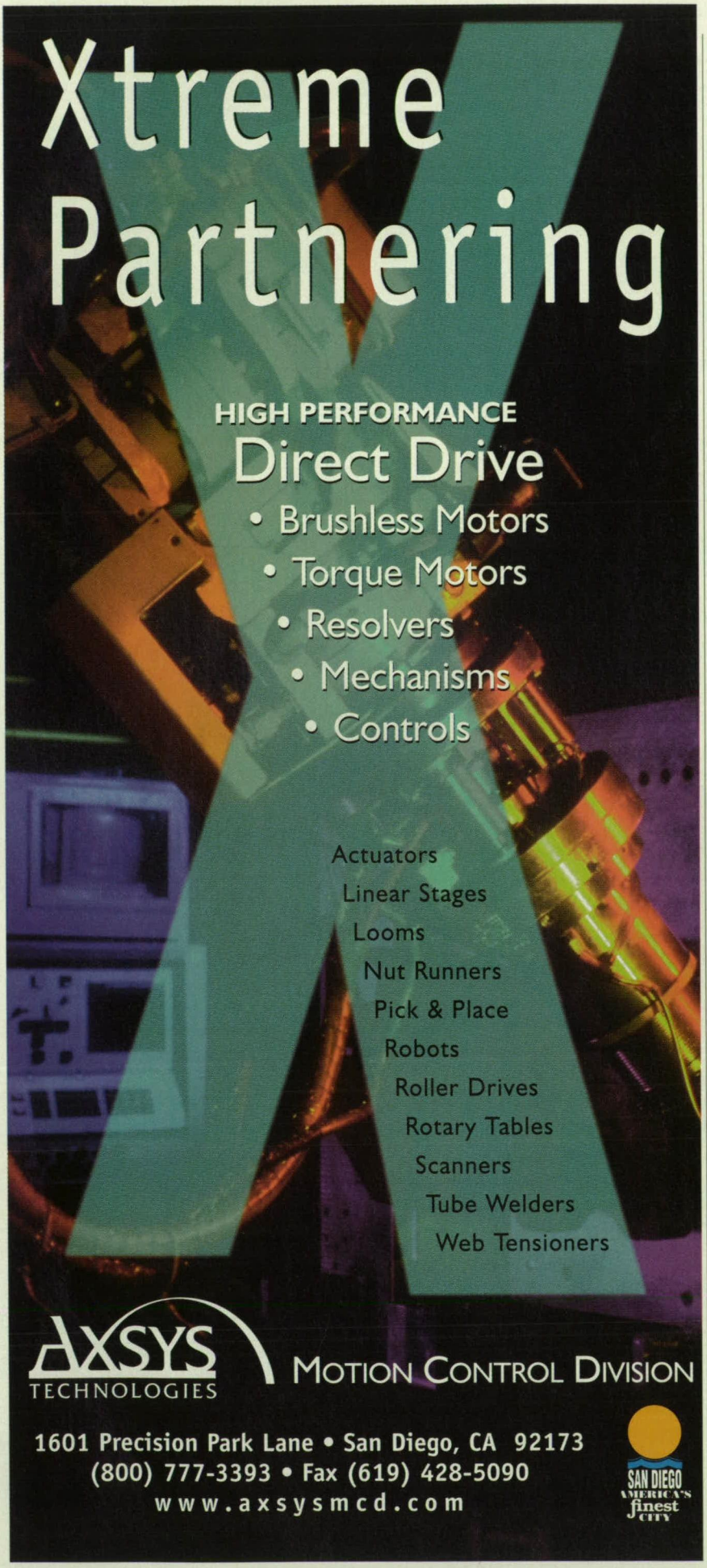
interpoint
A CRANE CO. COMPANY

Corporate Headquarters, USA
Redmond, Washington
Phone (425) 882-3100
Fax (425) 882-1990
E-mail power@intp.com

International Headquarters, UK
Phone +44-1252-815511
Fax +44-1252-815577
E-mail poweruk@intp.com

Interpoint France, Saint Gratien
Phone +33-134285455
Fax +33-134282387
E-mail powerfr@intp.com

Interpoint Germany, Darmstadt
Phone +49-6151-177629
Fax +49-6151-177654
E-mail powergr@t-online.de



and the shaft. Upon reaching the shaft, the flow splits into two smaller flows in opposite directions along the shaft. The combination of the clearance and the split flow of buffer gas constitutes the primary seal.

The secondary seal is a pressure-assisted, fluid-film seal between T ring and a housing that bounds the plenum. This housing is shaped approximately as a hollow ring of rectangular meridional cross section. The fluid-film seal between the housing and the T ring is effected by two tapered land seals. The pressure of the buffer gas in the plenum pushes these seals toward the housing, forming a low-friction clearance with the T ring. The tapered land seals are also lightly spring-loaded to hold them in place before gas pressure is applied. The secondary seal is a low-friction seal that tolerates sliding between the T ring and the housing. Thus, the T ring is free to track the runout (if any) of the shaft.

This work was done by Wilbur Shapiro and Henry F. Jones, Jr., of Wilbur Shapiro & Associates, Inc., for **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 176*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16339.

Two-Sided Tools for Layup of Composite Sandwich Panels

Less floor space is needed for tooling for large panels.

Lyndon B. Johnson Space Center, Houston, Texas

A simple change in the design of tools used in manufacturing laminated-composite-material sandwich panels reduces the floor area needed to store the tools. To give meaning to a description of this modification, it is necessary to explain the basic function

For More Information Circle No. 428

and original design of these tools: The basic function of such a tool is to provide a surface sized and shaped (possibly including a complex curvature) to match one of the two face sheets of the composite sandwich panel to be fabricated. A sheet of laminated composite material in uncured or partially cured form is laid up on the tool surface, then cured to form a face sheet (see Figure 1). The face sheet is then removed from the tool surface. The opposite face sheet is formed in the same manner on another tool, then the two face sheets are bonded to opposite faces of a honeycomb- or eggcrate-like core to form the composite sandwich panel.

Often, tools of this type have structures similar to those of the composite panels to be fabricated; the tools can include face sheets that define the tool surfaces and that are supported by honeycomb- or eggcrate-like structures. Often, the tools are even made of composite materials.

Each tool designed according to the original concept described thus far includes only one tool surface. The modified-tool concept calls for two tool surfaces for forming both face sheets of the composite sandwich panel that one seeks to fabricate. Like the panel itself, the tool of modified design features two face sheets (which define the two tool surfaces) bonded to opposite faces of a honeycomb- or eggcrate-like core (see Figure 2). To facilitate handling, the tool can be mounted in a steel frame; the mounting should be loose, with sufficient clearance to allow the tool to "float" in the frame to accommodate differential thermal expansion between the tool and the frame.

The biggest advantage of the two-sided tool design over the single-sided tool design is that twice as much mold-surface area is accommodated in the same floor area — an important consideration in the manufacture of large panels. In addition, the fabrication of two tool faces held on a common supporting structure involves less labor than does fabrication of two tool faces on individual supporting structures. The two-sided tool design could prove useful in the manufacture of a variety of curved composite-material sandwich parts; for example, boat hulls and outer shells of automobiles.

This work was done by David Altemir and Mike Fowler of **Johnson Space Center.** *No further documentation is available.*
MSC-22725

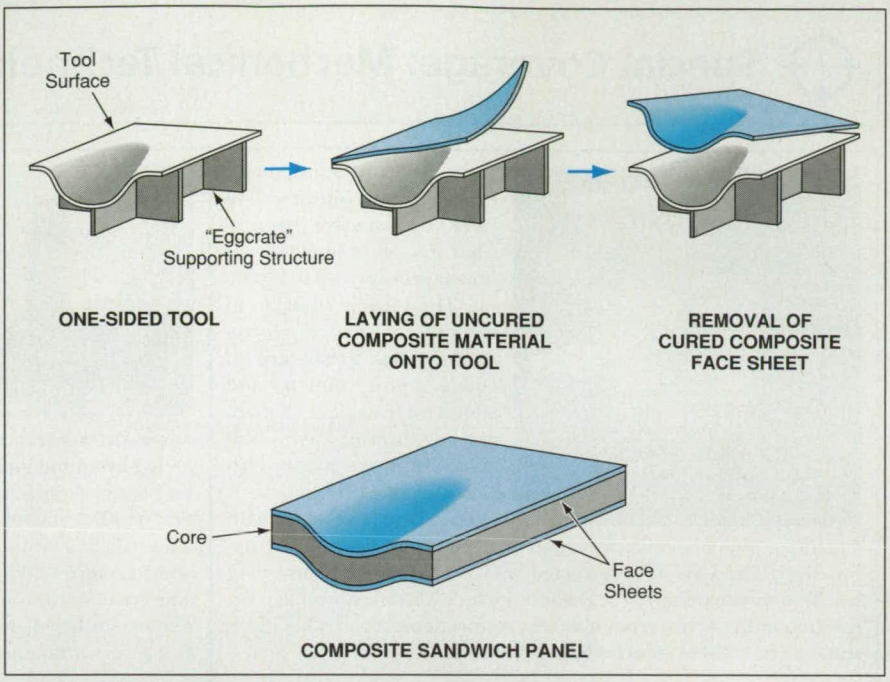


Figure 1. **Each Face Sheet** of a composite sandwich panel is formed by laying up and curing a sheet of laminated composite material on a tool surface that imparts the desired shape.

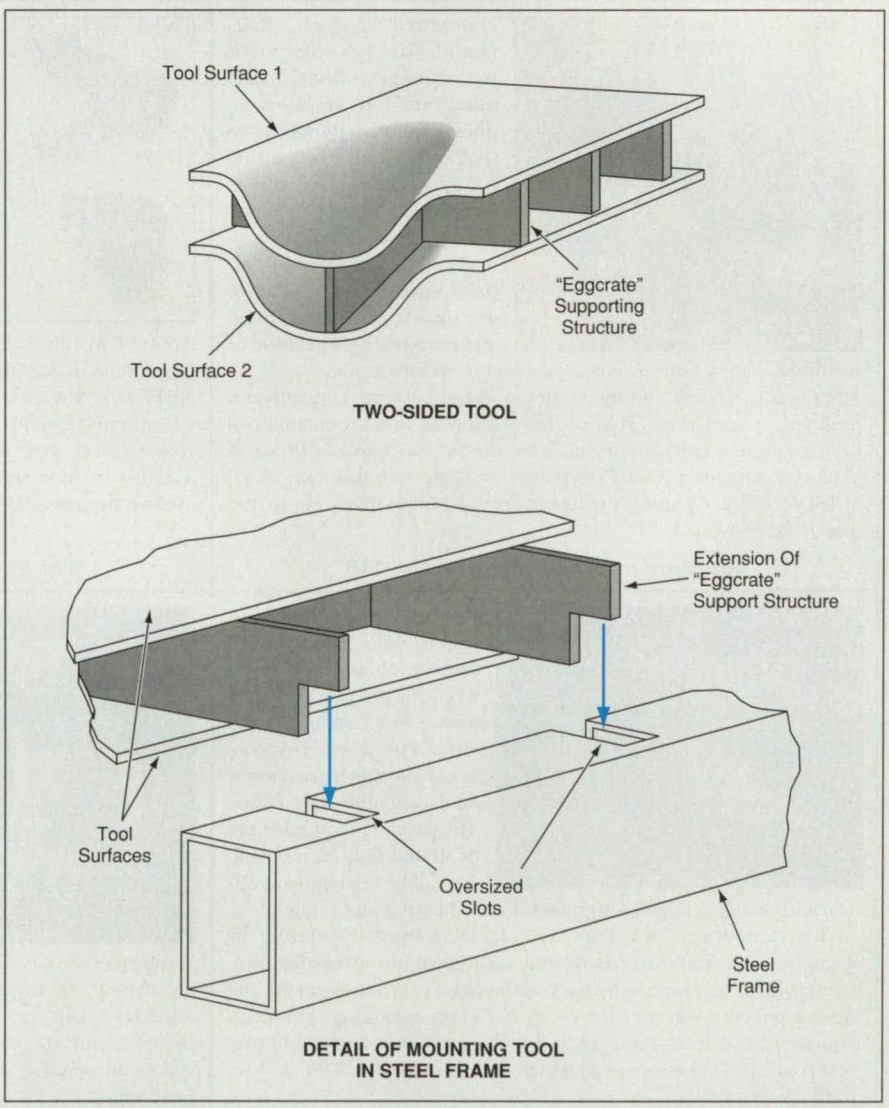
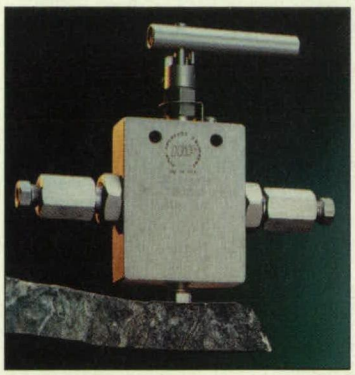


Figure 2. **This Two-Sided Tool** is similar to the one-sided tool of Figure 1, except that two tool faces are supported by a single structure. Thus, twice as much tool area is contained within the same floor area.



High Pressure Equipment, Erie, PA, has introduced a three-way **ball valve** that provides shut-off of liquid or gas flow at pressures up to 20,000 psi. The valve is available in two styles: a standard version that requires a half-turn to change port outlets and allows for complete shut-off; and a diverter style that allows for a one-quarter turn to change the port outlets.

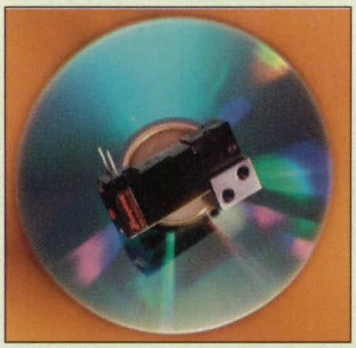
They are available with electric or pneumatic actuators and nearly all components are stainless steel. The valve is constructed with Teflon packing, providing leak-free service up to 450°F. Features include a stainless steel handle, dual mounting holes, removable seat connections, replaceable PEEK seats, a 316 stainless steel body and ball, and a blowout-proof stem.

For More Information Circle No. 735

Kelox™ threaded **inserts, studs, and lockrings** from Microdot, a division of Kaynar Technologies, Placentia, CA, provide mechanical attachment points in softbase materials. The fasteners are secured within a structure using a pair of self-broaching keys joined by an integral ring. The fasteners are supplied with the lockring temporarily joined to the fastener to assure the proper installation depth at the time of assembly.

Insert and stud materials include 17-4 PH corrosion-resistant steel and Inconel 718. Finishes are available in cadmium and silver plate, and dry film lubricants and passivate. The inserts and studs typically require smaller diameter installation holes within the parent material than other fasteners, preventing looseness.

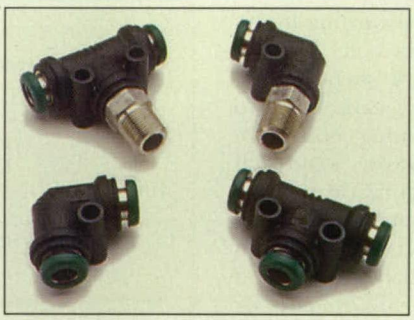
For More Information Circle No. 736



Humphrey Products, Kalamazoo, MI, has introduced the Nereus® Model HK5 multi-function single solenoid **diaphragm-poppet valve** that offers multiple porting configurations, allowing it to be used as a two-way or three-way, normally open or normally closed standard fill/exhaust valve, or as a selector or diverter. It can be mounted and plumbed on a subbase or manifold, with various electrical connector options available.

The valve has no sliding seals, no metal-to-metal contact, and requires no lubrication. It has a direct solenoid with an isolated coil having minimal armature travel. It features a choice of 4.5, 12, or 24 VDC coil voltages; 1.5 watt DC power consumption; flow rate of 3.0 SCFM at 100 psig; and a vacuum/pressure range of 28" Hg to 100 psig at 32°F to 125°F.

For More Information Circle No. 740



The Brass Products Division of Parker Hannifin Corp., Otsego, MI, has introduced Prestolok II **fittings** with stainless steel internal components and NPTF pipe threads for use with corrosive media. They have a composite body designed for operation from 0°F to 150°F at 150 PSI, depending on the tubing used. The fittings are available for 1/4" and 3/8" tubing, and with 1/8" and 1/4" NPTF pipe threads.

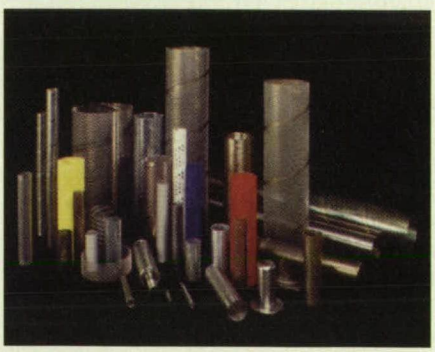
Configurations include union tee; elbow and Y connectors; male elbow swivel; run tee swivel; and branch tee swivel. The swivel designs are not suitable for live swiveling, impulse, or pressure cycling applications.

For More Information Circle No. 738

Reid Tool Supply, Muskegon, MI, offers **captive screw knob assemblies** that stay with the fixture, eliminating lost fastening hardware. The assemblies consist of a spring-loaded screw knob assembly and collet. They install in a single hole or slotted hole by inserting the collet through the fixture and securing it with a supplied bronze bearing and retainer.

When unfastened, the knob is held away from the fixture by spring tension, and the screw is fully withdrawn into the collet, providing a flush surface on the back of the fixture. When fastened, the knob is pulled down over the collet for secure clamping. The knob is made of cast iron; the stud and collet are made from 4140 preheat treat steel. They are available in thread sizes of 1/4-20, 3/8-16, and 1/2-13.

For More Information Circle No. 737

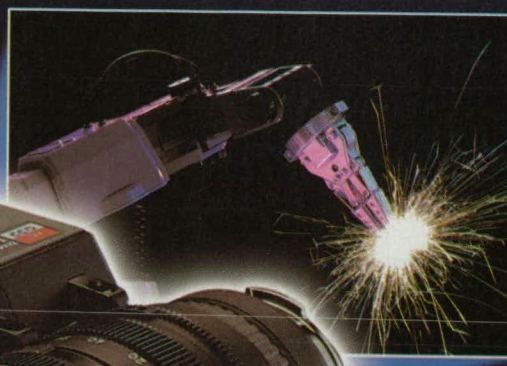


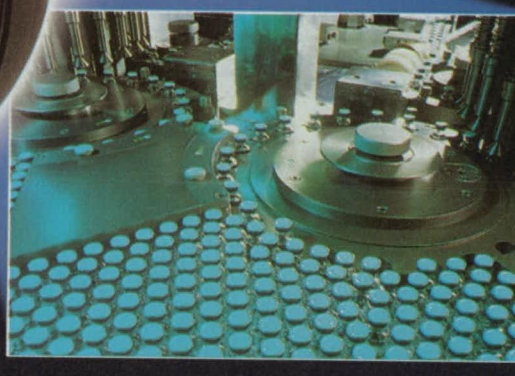
A line of **perforated tubes** in a variety of colors is offered by Perforated Tubes, Ada, MI. The tubes feature a baked-on, powder-coat finish and are suitable for lighting, grills, and other applications. The tubes provide light and air diffusion, electromagnetic interference shielding, and light weight.

Plated, electropolished, and unfinished tubes are available in materials such as mild steel, stainless steel, Monel, Hastelloy, Inconel, and titanium for a variety of applications including aerospace, automotive design, air and liquid filtration, and chemical processing.

For More Information Circle No. 739

Look To Canon For Solutions To All Your Image Capture Needs.





As video imaging becomes increasingly important in manufacturing, line inspection, automation, sorting, robotics, and machine vision in general, Canon continues to set the standard with superior optics that deliver unmatched quality and performance.

The worldwide leader in broadcast television lenses, Canon is equally committed to engineering the best industrial lenses, while providing real solutions for the broad range of high quality video user needs.

Our line of multi-use industrial lenses include the YJ17X9.5 KTS A, the YH17X7 KTS A and the YH13X7.5 KTS A. These lenses feature many important advantages such as super close-up, 17X zoom capability (found in the YJ17 and YH17), and other benefits normally associated with Canon's world-class broadcast television lenses. The lenses ca be used with most any 2/3" or 1/2" camera and offer remote control zoom, focus and iris functions available via our TCR-101F, 201F or 301F line of controllers.

Lightweight and sturdy, these lenses are also available with a simple interface for use with custom controllers.

Rely on Canon to meet and exceed the most demanding expectations. For more information, please call 1-800-321-4388.

Canon

The Number One Lens

Web site @ http://www.usa.canon.com

DESIGN ENGINEERING PRODUCT SHOWCASE

New Products and Services for* NASA Tech Briefs *readers. For more information, write in the corresponding number on the Free Information Request Card (preceding page 97).

PORTABLE NOMAD™ TEMPERATURE & TEMPERATURE/ HUMIDITY DATA - LOGGER

Omega's Nomad Series datalogger is a low-cost, easy-to-use, compact, portable datalogger, which can record either temperature or temperature/humidity data. The Nomad-T datalogger measures and records temperature using an internal temperature sensor from -40° to 70°C, or with the optional remote sensor from -40° to 123°C. The Nomad-RH measures and records both temperature from -40° to 70°C and relative humidity from 20 to 95% RH, simultaneously.

Omega Engineering Inc.

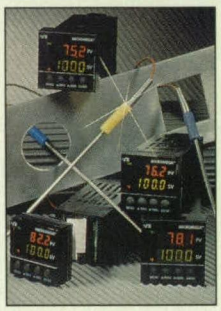
For More Information Circle No. 600

HANDHELD INFRARED THERMOMETERS

The portable, rugged OS520 Series infrared thermometers are ideal for non-contact surface temperature measurements. Features include adjustable emissivity, custom backlit LCD, high alarm setpoint, and optional laser sighting. Three models cover temperature ranges from -18°C to 870°C. Basic unit is $345.

Omega Engineering Inc.

For More Information Circle No. 601



1/16 DIN MICROMEGA® AUTOTUNE PID TEMP/PROCESS CONTROLLERS

The MICROMEGA® features a dual LED display, front panel configuration, selectable temperature/process inputs, and universal power supply that accepts 90 to 250 Vac or Vdc. Available in single and dual-output configurations. Basic unit is $219.

Omega Engineering Inc.

For More Information Circle No. 602

OMEGAFLEX® PUMP MOTOR

The OMEGAFLEX® FPU5-MT pump motor offers microprocessor control and a digital display, and is designed to be fully compatible with OMEGA's FPU500 pump. Calibrating the unit is easy with the user-friendly control software. Simply select a tubing size and the desired flow rate and the pump motor locks in the required RPM. Basic unit is $975.

Omega Engineering Inc.

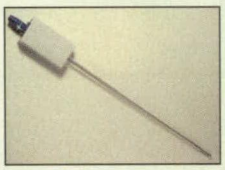
For More Information Circle No. 603

ECONOMICAL GAS MASS FLOW CONTROL SYSTEM

Designed to control the flow of non-corrosive gases, the FMA-1900 is designed to meet the same performance criteria as any industry-standard mass flow controller at half the price. The FMA-1900 provides digital readout of mass flow rate and setpoint adjustment on-board, and analog output for remote transmission. Basic unit is $795.

Omega Engineering Inc.

For More Information Circle No. 604

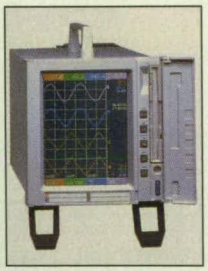


GENERAL-PURPOSE AIR VELOCITY TRANSDUCERS

The unique FMA-900 Air Velocity Transducer utilizes both a velocity sensor and a temperature sensor to accurately measure the air velocity in SFPM (standard feet per minute). The built-in rugged RTD temperature sensor automatically corrects the flow rate for temperature variations. Outputs are in 0 to 5 Vdc or 4 to 20 mA with a temperature range of -40 to 121°C. Basic unit is $822.

Omega Engineering Inc.

For More Information Circle No. 605

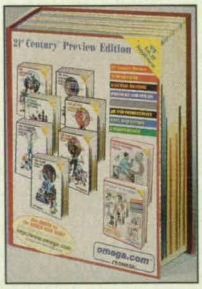


VR100 SERIES PAPERLESS RECORDER

The OMEGA® VR100 paperless recorder series offers real-time display of data on a color LCD display, and data storage on a standard 3.5-inch floppy disk. For enhanced reliability and performance, flash memory is used to hold data for a single download to the floppy when inserted. The unit measures up to four or six channels of signals from DC voltage, thermocouple, or RTD sources. Basic unit is $3,425.

Omega Engineering Inc.

For More Information Circle No. 606



VOL. MM™ 21ST CENTURY™ PREVIEW EDITION

Over 750 Full-Color Pages. Your source for the latest products in:

- Temperature
- Pressure and Force
- Flow and Level
- Data Acquisition
- pH and Conductivity
- Electric Heaters
- Environmental

Omega Engineering Inc.

For More Information Circle No. 607

MICROPROCESSOR-BASED PH & TEMPERATURE RECORDER

OMEGA's CTPH is a cost-effective recorder for pH and temperature ideal for facilities required to maintain a record of pH. The pH range is 0.2 to 12.0 with Automatic Temperature Compensation, using a unique electronically amplified probe that provides pH and temperature input to recorder unit through a 6-pin Mini DIN connector. Basic unit is $970.

Omega Engineering Inc.

For More Information Circle No. 608

Design Engineering Product Showcase

FREE CATALOG "OPTICS FOR INDUSTRY"

Free 130 page catalog from Rolyn, world's largest supplier of "Off-the-Shelf" optics. 24-hour delivery of simple or compound lenses, filters, prisms, mirrors, beamsplitters, reticles, objectives, eyepieces, plus thousands of other stock items. At off-the-shelf prices. Rolyn also supplies custom products and coatings in prototype or production quantities.

Rolyn Optics
706 Arrow Grand Circle, Covina, CA 91722-2199
Tel: 626-915-5707; Fax: 626-915-1379.

For More Information Circle No. 609

FREE DESIGN AID

Save layout time and eliminate detailing with this 16 page Template catalog. This catalog shows FULL SIZE drawings of many tooling components used in designing jigs and fixtures. It includes Spring & Ball Plungers, Nuts, Bolts, Washers, Knobs and many other items, all with sizes and part numbers. Also included will be a copy of the current catalog listing these and additional items, along with prices. Northwestern Tools, Inc., 3130 Valleywood Drive, Dayton, OH 45429; Tel: 937-298-9994; Fax: 937-298-3715.

Northwestern Tools, Inc.

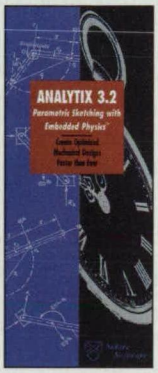
For More Information Circle No. 610

1998 MOTION CONTROL CATALOG

Galil's 1998 catalog is 128 pages with specs for ISA, PC/104, VME, and standalone motion controllers with RS-232. Features include: "Mix-and-match" steppers and servos on 1 through 8 axes, memory for application programs, uncommitted I/O, linear and circular interpolation, gearing and Ecam. Also, software for servo tuning and interface to AutoCAD, G-codes and Visual Basic. DOS, Win 3.1, 95 and NT. Catalog includes 28-page technical reference about motion control systems. Galil Motion Control, 203 Ravendale Drive, Mountain View, CA 94043; (650) 967-1700; 800-377-6329; fax (650) 967-1751; web site: www.galilmc.com

Galil Motion Control

For More Information Circle No. 611



MACHINE DESIGN SOFTWARE

For Designing Machines that Move. Analytix 3.2 for packaging of Manufacturing Equipment, Cams, Linkages, Pumps, Hydraulic Systems, Springs/Dampers, and More. 2D Parametric Sketching, Kinematics, Dynamics, Position, Velocity, Acceleration, Forces, Animation, Equation Solver, Tolerancing. DXF In/Out; Win 3.1/NT/95. FREE DEMO. Saltire Software Inc.; Tel: 800-659-1874, ext. 102; www.saltire.com

Saltire Software Inc.

For More Information Circle No. 612

PRESSURE TRANSDUCERS ADAPT EASILY

The new CVD 2200 Pressure Transducer adapts to almost any custom pressure ports and electrical connections. This feature, combined with programming capabilities via their ASIC chip, means these transducers can be easily tailored to meet virtually any application. The series uses a stable CVD sensing element to provide further flexibility and very high performance. Designed to operate from -40°F to 248°F, at pressures from 15 to 6,000 psi. Gems Sensors Inc., One Cowles Rd., Plainville, CT 06062; Tel: 800-847-5691 or 860-747-3000; Fax: 860-747-4244; www.gemssensors.com

Gems Sensors Inc.

For More Information Circle No. 613

CONSTANT FORCE SPRINGS & REELS

Colorful, 12-page brochure provides details on a line of stock and custom-designed spring-powered devices for the OEM design engineer. Includes power springs, NEG'ATOR® constant force extension springs, constant force spring motors, prestressed spiral springs, stock spring-powered reels, motor assemblies, RW® laminar springs. Contains typical applications and selection guide. AMETEK U.S. Gauge, Hunter Spring Products, Sellersville, PA; Tel: 215-257-6531; Fax: 215-257-3058; www.ametek.com

AMETEK U.S. Gauge, Hunter Spring Products

For More Information Circle No. 614

TIME & FREQUENCY PRODUCTS

TrueTime's precision time and frequency product catalog features GPS synchronized clocks in rackmount, board level, and portable configurations. These units are used for computer clock synchronization, telecommunication timing, time code generation, and a wide range of applications requiring precise time and/or frequency outputs. TrueTime Inc.; Tel: 707-528-1230; Fax: 707-527-6640; e-mail: truetime@truetime.com; www.truetime.com

TrueTime Inc.

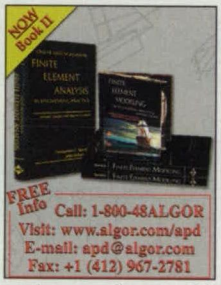
For More Information Circle No. 615

INSTRUMENT DATA ACQUISITION

The SoftwareWedge™ directs serial (RS-232, RS-485, RS-422) data from any instrument into any Windows 3.x, 95, or NT application such as Excel, MMIs, VB, Control, and Statistical applications. This configurable driver provides full data acquisition and control of PLCs, data loggers, scales, flow meters, lab instruments, etc. Please contact TAL Technologies, Inc., 2027 Wallace St., Philadelphia, PA 19130; Tel: 800-722-6004 or 215-763-7900; Fax: 215-763-9711; http://www.taltech.com

TAL Technologies, Inc.

For More Information Circle No. 616



LATEST BOOK TEACHES NONLINEAR FEA & MECHANICAL EVENT SIMULATION

Linear and Nonlinear Finite Element Analysis in Engineering Practice explores nonlinear and linear theory. *Finite Element Modeling in Engineering Practice* is the industry standard for linear analysis. CD-ROM has search engine and color graphics. Address: 150 Beta Dr., Pittsburgh, PA 15238.

APD

For More Information Circle No. 617

LEARN MORE ABOUT FEA

Finite Element Analysis in Action! is a proven, effective, instructional video and interactive CD-ROM for engineers. Live laboratory and computer demonstrations show how to better use any FEA software. Learn more about the basic physical principles behind FEA, how engineering judgment affects analysis, how tiny flaws affect material strength, boundary conditions and more. Address: 150 Beta Dr., Pittsburgh, PA 15238; Tel: 1-800-48-ALGOR; www.algor.com; apd@algor.com; or Fax: +1(412)967-2781.

APD

For More Information Circle No. 618

DOWNLOAD A FREE TRIAL OF SUPERDRAW III

Superdraw III is powerful CAD for engineering. Test drive the best precision finite element model building tool anywhere with our free trial software available at www.algor.com. Learn about Algor's FEA and Mechanical Event Simulation software, read Algor's newsletter and view frequently updated animations of FEA analyses. Address: 150 Beta Dr., Pittsburgh, PA 15238; Tel: +1(412)967-2700; www.algor.com; info@algor.com; or Fax: +1(412)967-2781.

Algor, Inc.

For More Information Circle No. 619

FREE *ALGOR IN ACTION* VIDEO AND CD-ROM

Free video has 18 action-packed minutes of real-world examples combined with Algor's Accupak/VE Mechanical Event Simulation demonstrations. Engineers use Accupak/VE to simulate real-world behavior of mechanical designs having motion or impact. CD-ROM has a variety of other new animations and technical information. Address: 150 Beta Dr., Pittsburgh, PA 15238; Tel: +1(412)967-2700; www.algor.com; info@algor.com; or Fax: +1(412)967-2781.

Algor, Inc.

For More Information Circle No. 620

Using a Jet Pump To Alter the Inlet Swirl of a Turbopump

With suitable design, turbopump oscillations can be suppressed.

Marshall Space Flight Center, Alabama

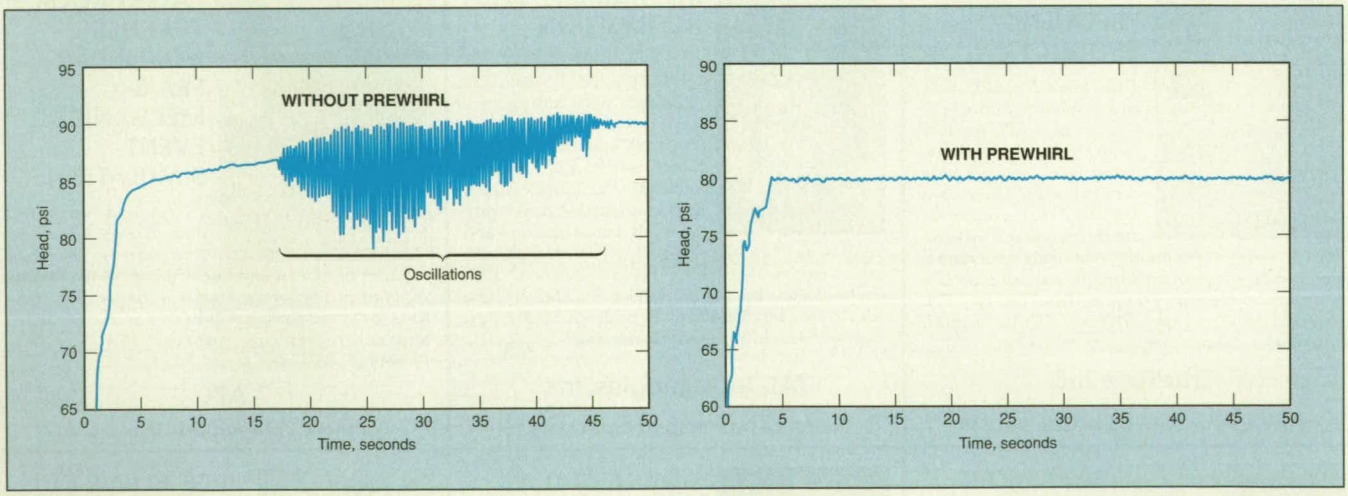
An analysis of empirical data on low-frequency oscillations in the inlet flow of a turbopump has led to the conclusion that these oscillations could be reduced or eliminated with suitable design of a jet pump to alter the inlet swirl. The oscillations in question are of fluid-dynamic origin and occur in the absence of externally supplied excitation, are related to cavitation, and are of approximately constant frequency and amplitude. They are undesired because they give rise to instabilities that can be transmitted to the thrust-chamber stage of the turbopump.

Heretofore, such oscillations have been suppressed by *ad hoc* measures determined by trial and error; e.g., incorporating holes into inducer blades, increasing inducer tip clearances, or prewhirl injection. The present concept involves a combination of (1) a more systematic approach in which one seeks to avoid the flow conditions that favor the oscillations and (2) recognition that jet pumps upstream of inducers or impellers have been found to increase the suction performances of turbopumps. Accordingly, one tries to suppress oscillations by designing either an axial jet pump or an angled-nozzle jet pump to improve suction performance and to alter the inlet flow conditions (in particular, the inlet swirl) in such a way and to such an extent as to prevent the oscillations.

Experiments have shown that the oscillations occur within restricted ranges of net positive suction head (NPSH), speed, flow rate, and angle of incidence of flow on inducer blades. Thus, according to the present concept, one could suppress the oscillations by, for example, designing a jet pump to inject prewhirl to bring the angle of incidence out of the range for oscillation at a given NPSH. The figure illustrates the results of an experiment in which oscillations in a liquid-oxygen turbopump were suppressed in this way.

This work was done by Sen Y. Meng and Laura A. Brozowski of Boeing North American, Inc., for **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category,* ***or circle no. 157*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

MFS-30086



Oscillations Were Eliminated by injection of high-pressure flow to introduce prewhirl into the inlet flow of a turbopump.

Adaptive Performance Optimization of Transport Aircraft

Control adjustments to obtain minimum drag are made automatically.

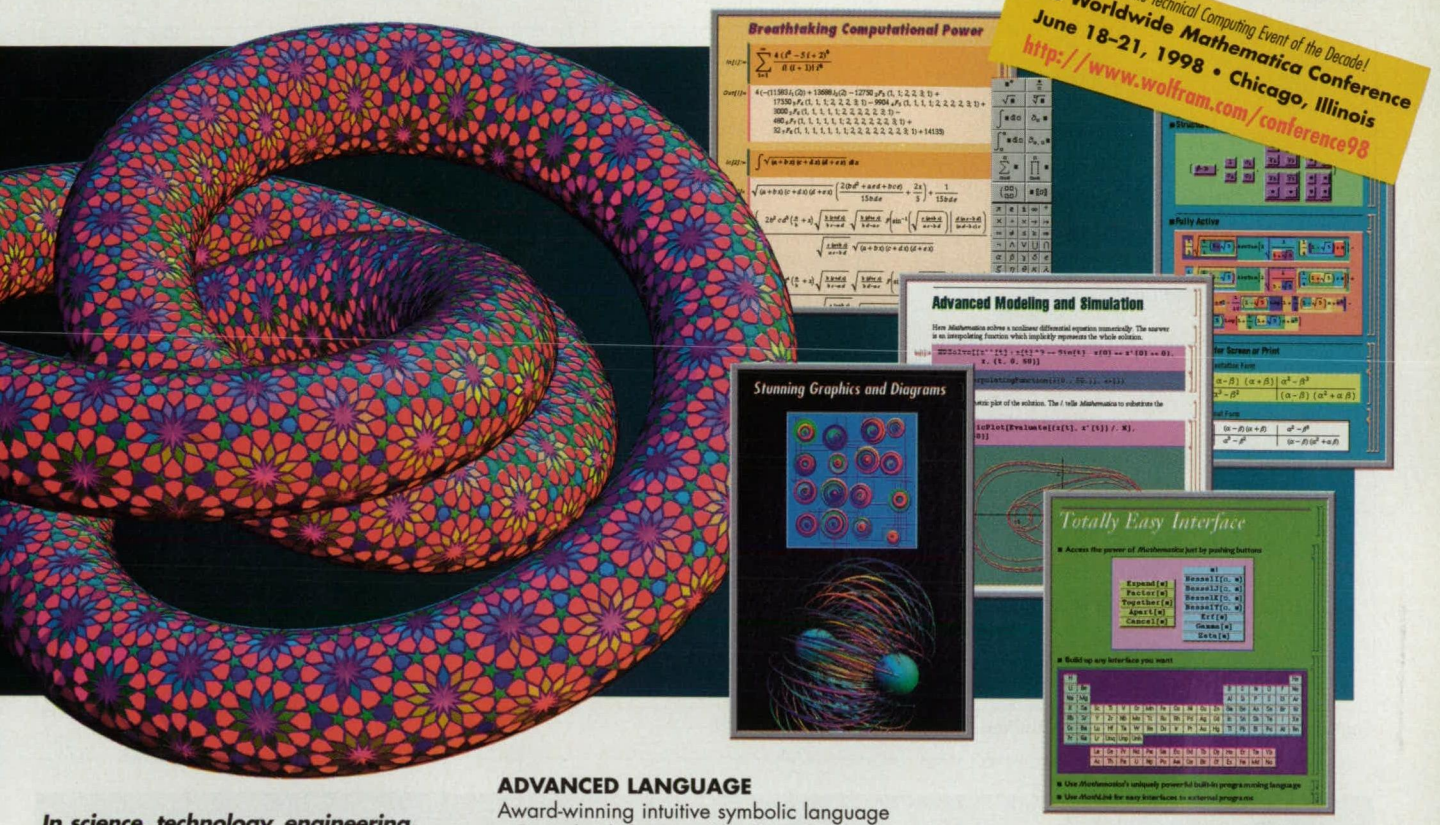
Dryden Flight Research Center, Edwards, California

Adaptive performance optimization (APO) is an approach for improving aircraft performance without the need for extensive modifications of hardware. In this approach, one exploits existing redundant control-effector capabilities by providing for automatic reconfiguration of control-surface deflections to achieve a minimum-drag trim condition.

The application of adaptive performance optimization (APO) to transport aircraft, utilizing redundant control effectors, can be a significant factor for improving the profitability of airlines.

MATHEMATICA®

THE WORLD'S ONLY FULLY INTEGRATED ENVIRONMENT FOR TECHNICAL COMPUTING



In science, technology, engineering, finance, medicine, research, education—over a million professionals and students now rely on Mathematica to do their work.

For projects large and small, from initial concept to final report, Mathematica has defined the state of the art in technical computing for nearly a decade.

NUMERICAL COMPUTATION

World's most complete collection of mathematical functions • Unlimited numerical precision • Matrix and tensor operations • Ordinary and partial differential equations • Fourier transforms • Data manipulation, fitting, and statistics • Root finding • Optimization • Number theory

SYMBOLIC COMPUTATION

State-of-the-art computer algebra algorithms • Simplification • Polynomial factoring and manipulation • Symbolic integration • Algebraic and differential equation solving • Symbolic matrix operations • General list and string processing

ADVANCED LANGUAGE

Award-winning intuitive symbolic language • Procedural, functional, list-based, rule-based, and object-oriented programming • Uniform symbolic expression representation of all objects • Fully scalable from small to large programs

GRAPHICS AND SOUND

2D, 3D, contour, and density plots • General 3D object visualization • Animation • Sampled sound • High-level symbolic graphics description language • Resolution-independent PostScript output • Export and import of standard graphics formats

PROGRAMMABLE INTERFACE

Customizable palettes • Free-form 2D input • Complete math notation • 700+ math and other characters • Programmable notation rules

NOTEBOOK DOCUMENTS

Interactive documents with text, graphics, sound, and math • Publication-quality editable typeset formulas and tables • Full range of formatting options • Automatic optimization for screen and print • Export capabilities in TEX, HTML, and more • Fully programmable symbolic representation • Free *MathReader*™

SYSTEM FEATURES

100% platform independent • Microsoft Windows, Macintosh, Unix/X • Unicode support • General *MathLink*® API • Distributed computing

APPLICATIONS LIBRARY

Over 30 products now available in data analysis, wavelets, time series, optics, astronomy, control systems, mechanical systems, structural mechanics, electrical engineering, finance, education, and more

FULL SERVICE

3000+ pages of award-winning on-line documentation • Three levels of technical support and consulting • 200+ books available • Volume discounts • Flexible academic site programs • Versions for students and teachers

Now Shipping VERSION 3.0.1
Released May 22, 1997

Information and purchases: http://www.wolfram.com/v3/ntb
or call 1-800-416-8069 All *Mathematica* products are available for Microsoft Windows, Macintosh, and most Unix platforms.

WOLFRAM RESEARCH
LEADERS IN ADVANCED COMPUTING

Wolfram Research, Inc.: http://www.wolfram.com; info@wolfram.com; +1–217–398–0700
Wolfram Research Europe Ltd.: http://www.wolfram.co.uk; info@wolfram.co.uk; +44–(0)1993–883400
Wolfram Research Asia Ltd.: http://www.wolfram.co.jp; info@wolfram.co.jp; +81–(0)3–5276–0506

© 1998 Wolfram Research, Inc. *Mathematica* and *MathLink* are registered trademarks of Wolfram Research, Inc. and are not associated with Mathematica Policy Research, Inc. or MathTech, Inc.

For example, the use of APO to effect a 1-percent reduction in drag for the U.S. fleet of wide-body transport airplanes could result in savings of approximately $140 million per year [assuming that fuel costs $0.70/gallon ($0.19/L)].

Preliminary design work has been performed for implementation of variable camber in transport airplanes, with APO serving as part of the basis of a new approach to actuation and control of wing trailing-edge control surfaces. The possibility of deriving a benefit from the application of APO to either a new full variable-camber design or to a retrofit to an existing transport airplane depends on the existence of a potential for optimization; in particular, it depends on

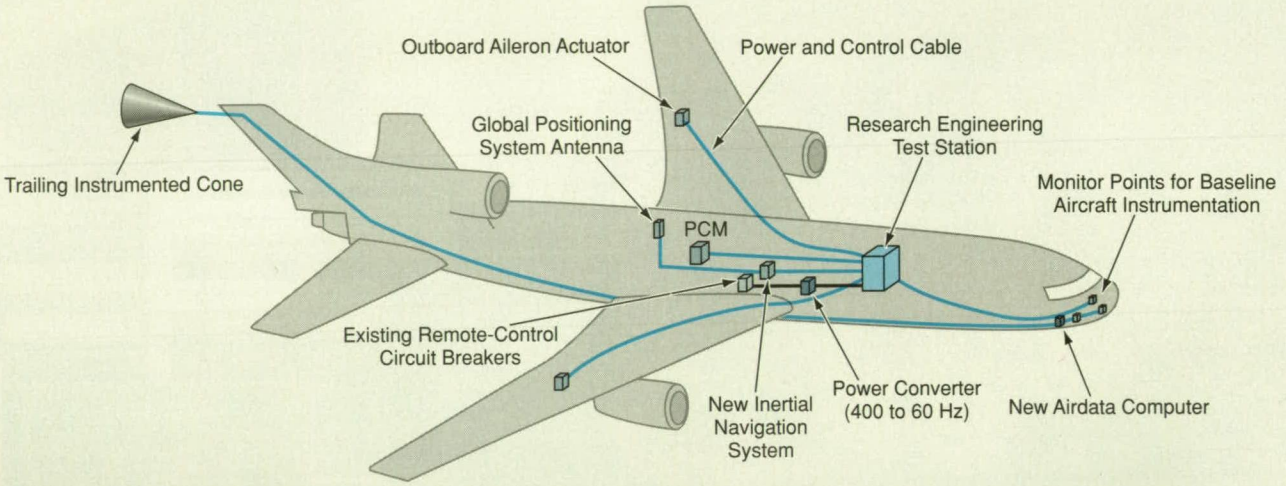
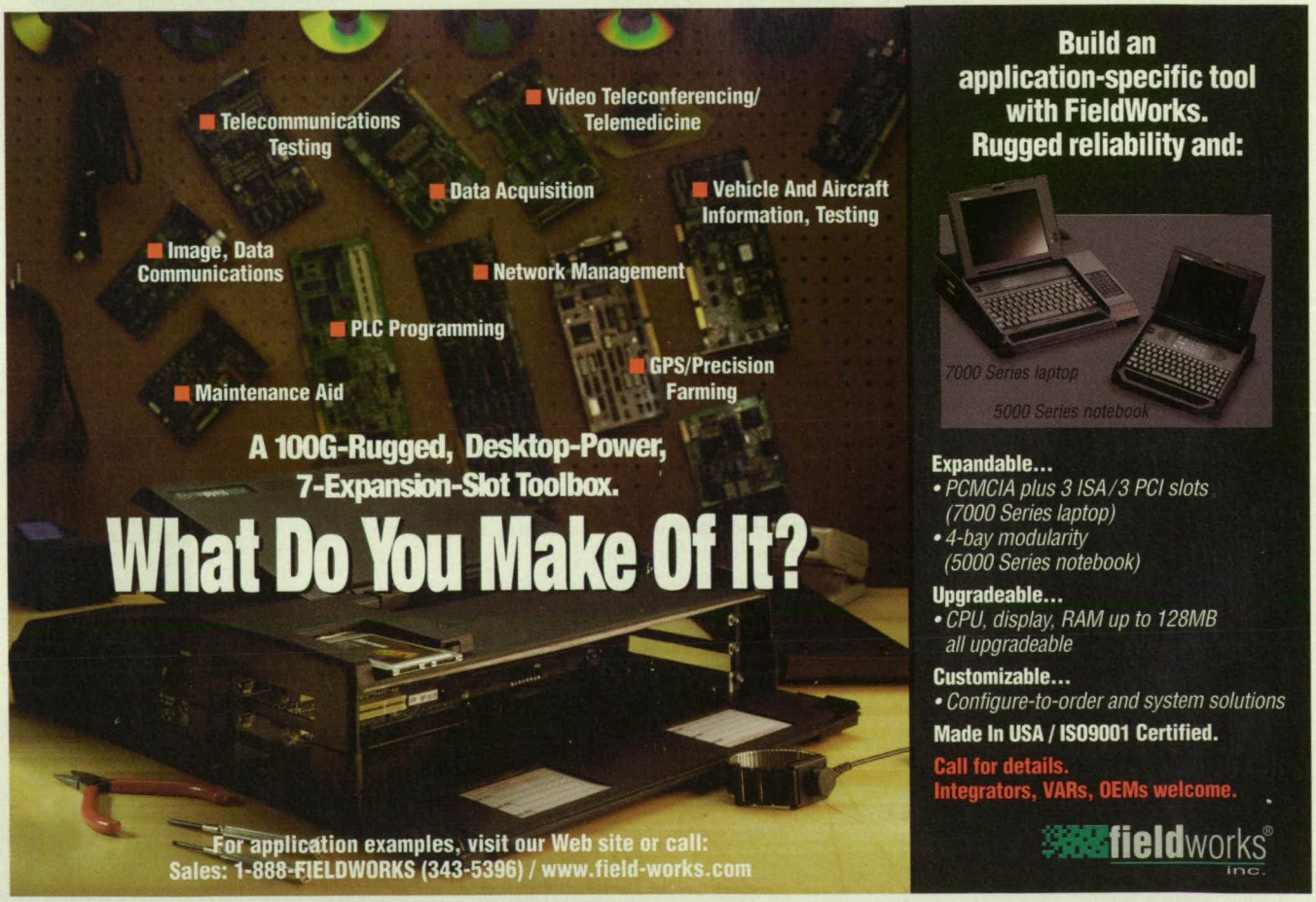


Figure 1. A **Transport Airplane Was Modified** for use in experiments on APO.



INTEGRATED FIBER OPTIC SOLUTIONS

WANNA SAVE SOME COPPER?

Spend some time with our fiber optic industrial cabling system.

If you're looking to save some copper – and we're talking more than just pennies – then check out our 200 micron industrial cabling system and we know you'll see the light. SpecTran Specialty Optics Company has a rugged, fiber based industrial cabling system that provides much lower systems cost than you might expect. The cabling system performs reliably over the full industrial temperature range, -40°C to +85°C. Our Crimp and Cleave connectors allow you to easily terminate in the field without the use of adhesives, polishing disks or solvents. So you get the benefits of fiber's immunity to RFI and EMI without the high cost of other fiber optic systems.

SpecTran Specialty can also provide ready to install fiber optic assemblies designed to meet your demanding requirements.

At SpecTran Specialty Optics Company, we don't just sell part numbers, we invest in partnerships.

Call 1-800-467-2329 ext. 99 for a SpecTran Spec Kit so you too can see the light.

SpecTran
SpecTran Specialty Optics Company

55 Darling Drive • Avon, CT 06001
(800) 467-2329 ext 99 • Fax (860) 678-6505

For More Information Circle No. 544

the existence of a redundant control-effector capability (that is, more than one means of trimming out the forces and moments to obtain a steady-state flight condition). Most transport aircraft have significant capability in this area, though in some cases, minor modifications could be necessary. APO addresses a systematic means of utilizing of this capability. Controls and/or variables that can potentially play a role in optimization of performance of current and future transport aircraft include elevator, horizontal stabilizer, outboard aileron, inboard aileron, flaps, slats, rudder, center of gravity, and differential thrust. The key technological challenge to in-flight optimization of performance of transport aircraft is identification of incremental drag to an accuracy better than 1 percent.

An L-1011 airplane has been modified for use in a NASA program of flight research in APO for transport airplanes. The modifications (see Figure 1) consist of (1) addition of a research engineering test station; (2) addition of an actuator (one on each wing) to drive the outboard ailerons symmetrically; (3) addition of an instrumented trailing cone to obtain true static pressure; (4) connecting into the basic airplane instrumentation system to obtain engine, control surface, and other measurements; (5) addition of an embedded navigation system with Global-Positioning System (GPS) and inertial-navigation subsystems; (6) addition of a state-of-the-art airdata computer; and (7) addition of a data-recording system.

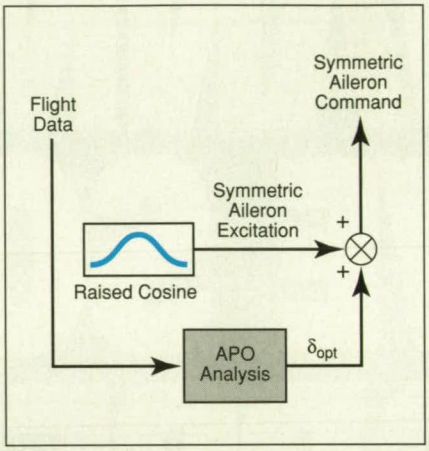


Figure 2. The **APO Algorithm** analyzes flight data and adjusts symmetric aileron deflection to minimize drag.

In the cruise mode, the APO algorithm commands a smooth, long-period excitation of a redundant control surface — specifically, a symmetric excitation of outboard ailerons. The forced excitation is smooth enough and of sufficient duration that the mach- and altitude-hold autopilot modes "mask" the quasi-steady pitching-moment drag changes that occur during maneuvers that involve changes in the throttle setting, stabilator angle, and/or angle of attack. The resultant data are analyzed to determine the minimum-drag configuration, and the redundant controller is configured appropriately (see Figure 2).

This work was done by Glenn B. Gilyard of **Dryden Flight Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category,* ***or circle no. 198*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Technical Information Specialist, Dryden Flight Research Center; (805)258-3720. Refer to DRC-95-22.

Vacuum Connectivity

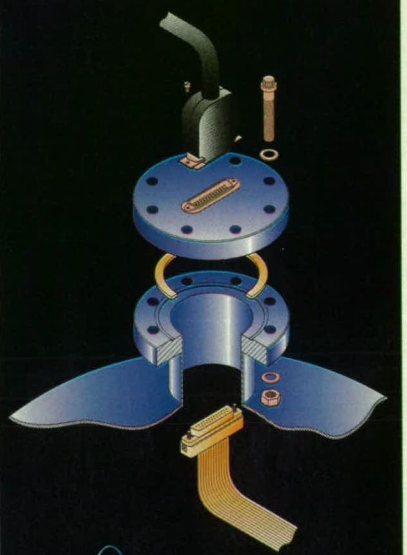
Building-Blocks for Vacuum Science and Technology

Complete air-to-vacuum instrumentation connectivity

MDC offers a complete solution to the problem of ultra-high vacuum, low voltage, multipin instrumentation connectivity. Expanding on the popular Type-D subminiature connector standard, we are pleased to offer a new range of UHV feedthroughs with 9, 15 or 25 pins hermetically sealed and electrically insulated using the latest in glass-ceramic bonding technology.

MDC provides a complete connectivity solution. Complete air-side Type-D connectors are included with each hermetic feedthrough assembly. For in-vacuum connections we have developed a unique combination of in-vacuum ribbon cables and Type-D connectors, constructed to meet the rigorous demand of UHV environments.

For additional information on this product or MDC's full range of vacuum components, call 1-800-443-8817.

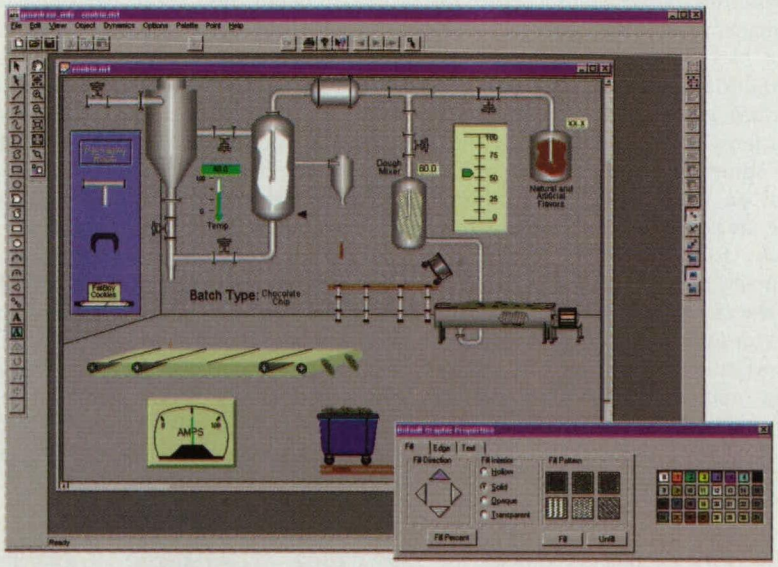


MDC
VACUUM PRODUCTS CORPORATION
23842 Cabot Boulevard,
Hayward, CA 94545-1661
Phone: 510-265-3500
Fax: 510-887-0626
www.mdc-vacuum.com
e-mail: sales@mdc-vacuum.com

SL-GMS The High-Performance Standard for Embedded Dynamic-Graphics Subsystems

A flexible, easy-to-use tool for developing animated displays for real-time applications

SL-GMS is a proven dynamic graphics engine, with the features needed to quickly create dynamic displays for real-time applications. Designed for easy integration into interactive environments, SL-GMS offers functionality well-suited to applications that contain a complex network of active data.



SL-GMS being used for animation in a process control application

FUNCTIONALITY

- Non-programmatic development of complete graphical user interfaces
- Support of Motif widgets and NT control objects
- Customizable editor
- Support of imported vector and bitmap backgrounds
- Moving objects across background maps
- Dynamic vector objects (lines, circles, etc.) that change attributes to represent changing application variables
- Dynamic display of application data through plots and trends

FLEXIBILITY

The SL-GMS Draw component is a powerful graphical editor equipped with advanced capabilities for creating custom screen objects, as well as specifying the dynamic behaviors of those objects directly within the editor. SL-GMS greatly simplifies the building of layered applications. SL-GMS offers State Class Libraries that allow developers to easily create multi-layered sets of screens to control and animate complex application displays. Because SL-GMS encapsulates the basic elements of dynamic screens into objects, users are freed from the complex programming logic that is otherwise required to manage constantly updating layers of screens.

The SL-GMS real-time dynamics graphics engine embodies years of optimization in handling large data sets. This allows many different techniques for achieving maximum performance under diverse application requirements.

PORTABILITY

SL-GMS provides developers flexibility in the choice of hardware platforms. Support is provided for nearly all varieties of UNIX (X/Motif) on SUN, SGI, HP, IBM, MIPS, DEC (OpenVMS, VAX/Alpha, Digital UNIX), Windows NT (Intel, Alpha) (MFC, OLE, ActiveX), SCO, QNX®.

- Cross platform portability
- Under Windows NT, SL-GMS can be integrated as an ActiveX control component
- SL-GMS can be seamlessly integrated and displayed in a Web page via a Netscape plug-in
- Smooth pan, zoom, and decluttering

Call today for further technical information:

U.S.	*1 415 927 1724*
Canada	*1 514 875 2643*
England	*44 1403 273173*
France	*33 1 69 07 32 18*
Germany	*49 511 965250*
Spain	*34 1 319 97 32*
Romania	*40 1 312 3160*
Australia	*61 49 577 002*
Israel	*972 4 845 0370*
Japan	*81 3 3423 6151*
Korea	*82 2 556 1251*
Brazil	*55 21 533 2226*

SL
Sherrill-Lubinski

SL Corporation
Suite 110 Hunt Plaza
240 Tamal Vista Boulevard
Corte Madera, California 94925
http://www.sl.com

©1998 Sherrill-Lubinski Corporation
All trademarks mentioned are property of their respective companies.

Removable Fillers for VPS Fabrication of Closed Channels

These ceramic materials can withstand high processing temperatures.

Marshall Space Flight Center, Alabama

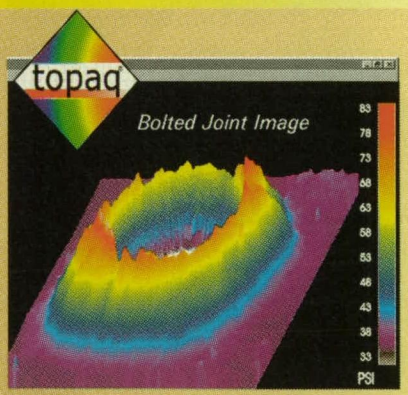
An improved process has been devised for making closed channels (e.g., coolant channels) in a heat-exchanger liner or a similar metal object. The process involves the following steps: First, grooves destined to become closed channels are machined into the object from one surface. Next, a ceramic filler material is troweled into the grooves, made flush with the surface, and allowed to harden by evaporation of water. Next, vacuum plasma spraying (VPS) is used to deposit metal on the exposed metal and filler surface areas to cover the grooves and thereby form closed channels (see figure). Finally, the filler material is removed from the channels. This process satisfies a need for making the channels at lower cost and in less time than is possible by an older process in which the grooves are filled with wax, then a thin layer of copper is electroplated on the exposed metal and wax surface areas, then a thick nickel structural jacket is deposited on the copper.

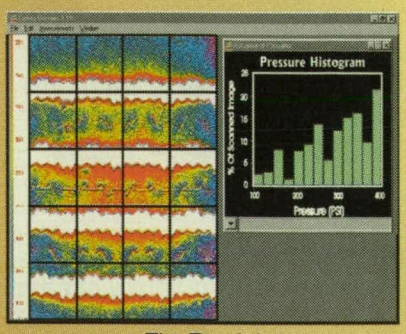
The success of the process depends on the proper choice of the filler material. A ceramic is attractive for this purpose because, unlike wax, it can withstand the VPS process temperature. The filler is required to be sufficiently fine-grained to enable the deposited metal to have a sufficiently smooth surface [32 μin. (0.8 μm) in the original application for which the process was devised]. The filler is also required to be removable after VPS.

The ceramic filler materials found to be most suitable are mixtures of silica powder with water and various proportions of sodium silicate or colloidal silica, which serve as binders. A third binder made of a cellulose ether compound can be used in combination with either of the other two binders to tailor the viscosity of the overall mixture for both troweling the filler into the channels and removing the filler after VPS.

It is desirable to facilitate and accelerate post-VPS removal of the filler by providing flow paths for flushing the filler out of the channels. For this purpose, before the filler material is troweled into the channels, a yarn or rope made of a polymeric material is placed in the bottom of each groove, extending beyond the ends of the groove. The polymeric material should be either one that decomposes and shrinks at the high VPS process temperature or else one that can be pulled out after hardening of the filler or after VPS. After VPS, the filler can be flushed

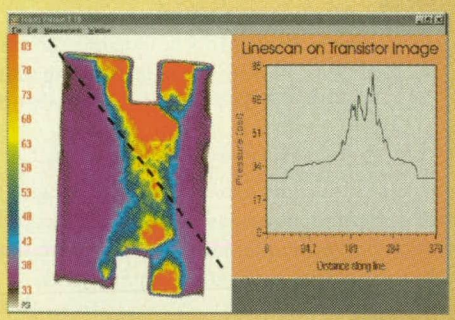
New Sensor Interprets Tactile Stress Distribution





Tire Tread Image

Topaq® is a revolutionary stress measurement system for tactile force measurement and interpretation. Topaq's Windows-based software enables the characterization of how force is disbursed in any process or assembly where two surfaces come into contact or impact. Used in conjunction with Fuji Prescale and Pressurex pressure indicating films, Topaq renders high definition color maps revealing both pressure *distribution* and *magnitude*. Unlike FEA, Topaq is a post-process interpretive system that actually collects data from a proprietary tactile transducer. Extremely user-friendly, Topaq requires minimal calibration, preparation, and user training. Topaq's powerful single key-stroke commands allow you to instantly produce informative visuals and a host of statistical information. Reports include histograms, average pressure, total force, and total area of contact. Additionally, single or multiple regions of interest can be magnified and evaluated, enabling you to discern microscopic variations of pressure. Topaq is accurate to within ±1% full scale.



Transistor Mounted on a Heat Sink

The Topaq system consists of a scanning unit, interface cables, expansion card, software and a sample pack of the tactile transducer materials. To learn more about Topaq or to arrange for a product demonstration, call, fax, or email.

SPI
SENSOR PRODUCTS INC.

(800) 755-2201
24 Castle Ridge Park
East Hanover, NJ
07936-3547 USA
FAX: (973) 884-1699
sales@sensorprod.com
www.sensorprod.com

Spend Your Time Acquiring Data

Not Configuring It.

Introducing DAstar. Ready-To-Use Data Acquisition With Recorder-Like Simplicity.

DAstar is data acquisition that's ready to use when you get it. No time consuming training. No custom board configuration. And no complex user interface to set up testing parameters. It's a completely integrated system that includes high performance, programmable signal conditioning, acquisition and analysis software and an available thermal writer for real time hard copy. Best of all, it maintains recorder-like ease-of-use. It also features excellent data presentation for viewing 4 real time displays on a single screen, simultaneous sampling, event triggering, mixed inputs, a lightweight rugged chassis designed for use in the harshest environments, and DC operation from 10-50V is available.

If you're looking for precise and reliable data acquisition that's as easy-to-use as it is ready to go—get the facts on DAstar. Call us at 216-328-7000 for complete product literature.

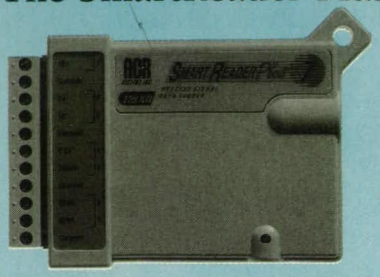
GOULD
Instrument Systems

1-800-468-5365 • Fax: 216-328-7400 • www.gouldis.com

For More Information Circle No. 517

Essential Test Equipment

The SmartReader Plus 7 can measure & record



- Temperature
- Humidity
- Pressure
- Vibration
- Flow
- Current
- Voltage
- And more...

It features
- 8 channels
- 87,000 readings
- 12-bit resolution
- ±0.5% accuracy F.S.
- NIST traceability
- Alarm dialout

We offer you
- Free tech support
- Free software upgrades
- 3-year warranty
- Year 2000 compliance

Give us a call
1-800-663-7845
Fax: 1-604-591-2252
acr@acrsystems.com
www.acrsystems.com

ACR SYSTEMS INC.

An ACR Data Logger

For More Information Circle No. 433

Many Options For Your Specific Needs

Versatility To Meet Your Applications

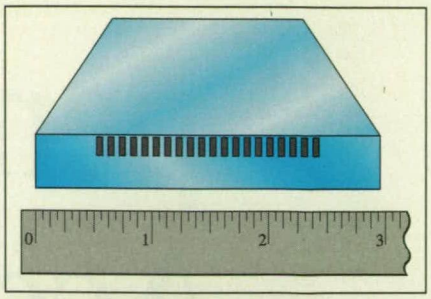
- **Circulators**
- **Chillers**
- **Water Baths**
- **Complete Instruments Or Sub-Assemblies**
- **OEM Inquiries Welcomed**

PolyScience Offers A Wide Range Of Laboratory Heating & Cooling Instruments. Send Now For Your **FREE** Brochures!

PolyScience

800-229-7569 www.polyscience.com

6600 West Touhy Avenue, Niles, IL 60714, 847-647-0611



Channels in a Solid Metal Plate were formed by VPS of metal onto ceramic-filled grooves and adjacent areas of the top surface. In the initial experiments on this process, the plates and the deposited material were made of copper.

out of the completed channels; for example, by alternating flows of pressurized water and a hot NaOH solution.

This work was done by D. Andy Hissam and Frank Zimmerman of **Marshall Space Flight Center** *and William M. Davis, Phillip Krotz, Yoon K. Liaw, Peter Oelgoetz, and Heather Sanders of Rockwell International Corp. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 123*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
MFS-30124

Controlled-Orientation Short-Fiber Composite Bodies

Microstructurally controlled composite properties mimic biomaterials.

Marshall Space Flight Center, Alabama

A technique for depositing materials into position using a positive-displacement extruder to build up a body has been developed. This technique also includes a process to prepare composite materials through a solid free-body forming process containing directionally aligned short-fiber reinforcement and ceramic-particulate reinforcement (of which at least a portion is derived from an alkoxide precursor).

With this newly developed technique, the matrix resin contains fiber and/or high loadings of ceramic particulate (precursor). The fiber reinforcement is oriented by shear stresses in the extrusion process. The matrix resin has very low shrinkage and is capable of being cured in a short time after deposition.

This new technique for depositing

If only he had

Avery Dennison.

Our pressure-sensitive adhesive tapes perform under

Extreme Heat.

Remember Icarus? Flew too close to the sun and melted the wax in his wings. Another design idea gone bad. Too bad he used the wrong fastening material.

If only he had Avery Dennison™ ultra-high adhesion fastening tapes. Their patented adhesive technology maintains a strong bond at temperatures up to 450° F. The tapes also provide the high shear strength, ultra-violet stability, and solvent resistance so vital to today's automotive and appliance applications—especially brake shoe assemblies, engine labeling, gasketing and vibration dampening.

Avery Dennison ultra-high adhesion fastening tapes are available in various constructions: unsupported transfer tapes for total conformability to curved surfaces; double-coated carrier tapes for optimal processing. The firm adhesive is easily die-cut and available in heavier coat weights for a secure bond to rough or irregular surfaces.

The sky's the limit when it comes to designing with Avery Dennison. For more information on how to stick when the heat is on, call **1-800-262-2400, ext. 2663** or fax 440-639-7518. And be sure to ask for the free Application Engineering Guide.

Brake Shoe Assembly

ISO 9001 CERTIFIED

For More Information Circle No. 528

Specialty Tape Division
250 Chester Street
Painesville, Ohio 44077
(440) 639-2600

AVERY DENNISON

Avery Dennison™ is a trademark of Avery Dennison Corporation.
ADV# 1374 2.5M 8/97

materials into position uses a stereolithography system, comprised of a table and computer-controlled gantry system, a vertical slide and resin dispenser, and a heated platen. A computer-aided-design package is used to make a virtual image of a solid body. The computer translates the virtual image into motion instructions, which are, in turn, converted to indexer commands and motions of the resin dispenser. The resin dispenser extrudes resin through a needle while sweeping out a path to build up the solid body on the heated platen. The resulting part is thermally cured during or after deposition.

Composite resin systems were developed for this process based on specialty acrylic monomers. These monomers combine short chains of structural polymers with acrylate end groups. Upon curing, the acrylate end groups join, forming a polymer with properties similar to the structural polymer. A cross-linking agent was used to promote rapid curing. This resin system produces a tough, strong polymer within several minutes when heated, with very low shrinkage upon curing.

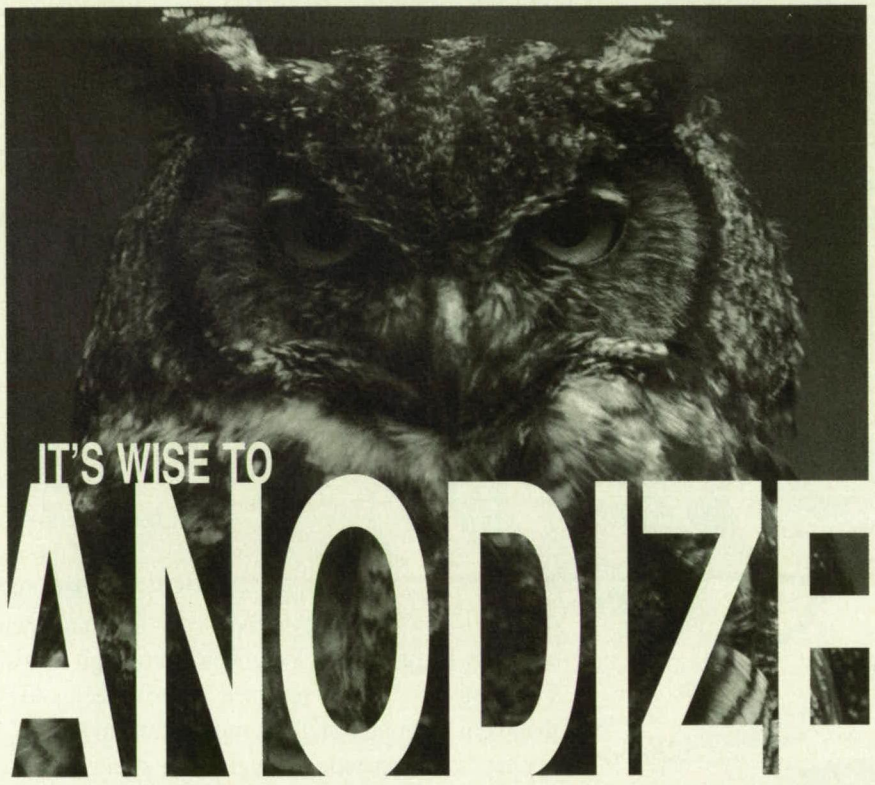
An advantage of this resin deposition system is that it has a low viscosity. A viscosifier is required to lay the material up. It was found that the addition of 1.66 volume percent fumed silica provided sufficient viscosity so that beads of the material could be neatly laid up. The viscosified resin was reinforced with chopped carbon or glass-fiber and ceramic particulate.

This solid free-body-forming process was used to produce controlled-alignment fiber-reinforced composites. Also, highly loaded ceramic particulate reinforced composites were prepared using this method.

Flexure testing of composite specimens showed the properties to be quite respectable when compared to traditional structural polymer materials. These tests also demonstrated that the specimens were far better than the materials that are currently produced by other solid free-body-forming technologies.

This work was done by Kevin Stuffle, Gabriel Chambers, John O'Kelly, John Lombardi, Anthony C. Mulligan, and Paul Calvert of Advanced Ceramics Research, Inc., for **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 159*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (205) 544-0021. Refer to MFS-26445.



In today's environmentally-conscious world, it's survival of the fittest. Cost-effective and environmentally safe hard coat anodizing enhances the basic properties of aluminum such as, low density, high dielectric constant, thermal conductivity, lubricity, malleability, and ductility with a hardness comparable to a **C-70 Rockwell** after hard coat. Resist the elements of rust and corrosion, moisture, heat, cold, friction, and the basic element of surprise!

It's a matter of *"WHOOOS"* product will last.
Let us anodize your sample part for free. Call, fax or write:

FWA

It's not how it's made. It's how it's made to last.

Fort Wayne Anodizing
Full Anodizing and Impregnation Services
2535 Wayne Trace • Ft. Wayne, Indiana 46803 • Phone 219-424-1030 • Fax 219-420-4006
Toll Free 800-347-1030

Fabrication of Thin-Film Type-S Thermocouples

These thermocouples can be used to measure surface temperatures.

Lewis Research Center, Cleveland, Ohio

Processes for fabricating thin-film type-S thermocouples on metal and silicon nitride substrates (see figure) have been developed. (A type-S thermocouple comprises one leg made of platinum and the other leg made of an alloy of platinum with a rhodium content of 10 percent.) Thin-film type-S thermocouples can be used to measure temperatures on the surfaces of metal and ceramic components and are intended, especially, for use as monitoring and control sensors in the development and operation of advanced engines.

The fabrication processes involve numerous steps. Combining and summarizing some steps for clarity, the processes can be described as follows:

Mathcad 7.0 Pro compatible!

Fast

- Intelligent parametric CAD
- Visual prototyping with 2D kinematics
- Design time cut from weeks to days

Easy

- OLE 2.0 compatible
- Built-in Web browser
- Visual feedback that speeds design

Powerful

- AutoCAD® and MicroStation® compatibility
- Easy customization with Visual Basic® and other tools
- High-end design capabilities everyone can afford

Intergraph's Imagineer Technical – The Best of the Best!

1997 Editors' Choice Awards CADENCE

"Maybe you can't fall in love with software, but Imagineer Technical 2.0 certainly does seduce. It starts with the first object drawn, and before you even mean to, you might find that you've actually made something useful, such as a whole drawing. It occurs to you that you've done it without opening the manual or consulting any tutorials. ... If you're like us, you wish that all CAD software would be this enjoyable."

– Excerpt from *CADENCE* Editors' Choice Award, December 1997

INTERGRAPH Imagineer™ Technical

The ultimate engineering think tool!

Order Imagineer today!

Money-back guarantee!

1-800-292-9761

Mention priority code IgrNA.

http://www.intergraph.com/imagine

INTERGRAPH

Intergraph and the Intergraph logo are registered trademarks and Imagineer is a trademark of Intergraph Corporation. MicroStation is a registered trademark of Bentley Systems Inc. AutoCAD is a registered trademark of Autodesk Inc. Visual Basic is a registered trademark of Microsoft Corporation. Mathcad is a registered trademark of MathSoft Inc. Other brands and product names are trademarks of their respective owners.
Copyright 1998 Intergraph Corporation, Huntsville, AL 35894-0001. 1/98 MC380098

The process for fabrication on a metal substrate begins with polishing and cleaning the substrate. The clean substrate is precoated (by vapor deposition) with NiCoCrAlY to a thickness between 50 and 120 μm. The precoated substrate is cleaned and oxidized to form an electric surface layer of α–Al_2O_3.

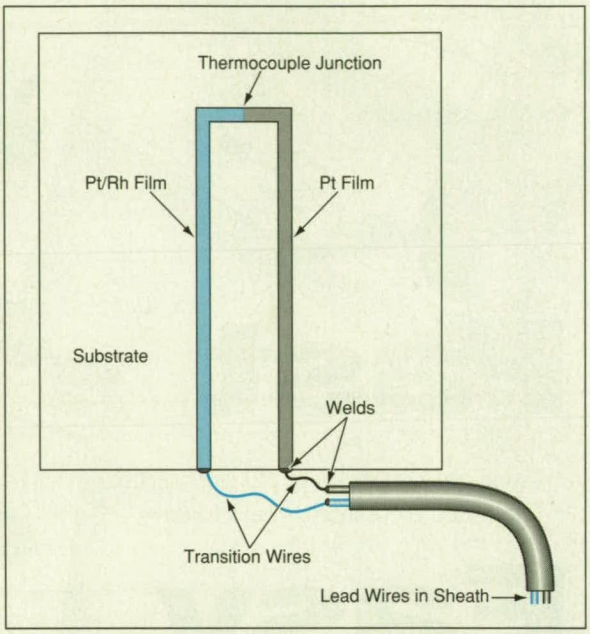
A photoresist is applied and patterned with an opening for the Pt leg of the thermocouple, and the Pt leg is deposited by sputtering to a thickness between 2 and 3 μm. After removal of photoresist and further cleaning, a new photoresist mask for the Pt/Rh leg of the thermocouple is formed, then the Pt/Rh leg is deposited to a thickness of 2 to 3 μm. The second photoresist mask is removed, the workpiece is cleaned, and a protective overcoat of Al_2O_3 is deposited on vulnerable portions of the thermocouple legs to a thickness between 1.5 and 2.0 μm.

Transition Pt and Pt/Rh wires with a diameter of 3 mils (≈76 μm) are welded to the outer contact ends of the Pt and Pt/Rh thermocouple films, respectively. Then external 0.020- or 0.040-in. (0.5- or 1.0-mm)-diameter sheather lead wires of Pt and Pt/Rh, respectively, are welded to the outer ends of the Pt and Pt/Rh transition wires. The transition wires and their welded junctions are covered with a ceramic cement.

The process for fabrication on a silicon nitride substrate also begins with polishing. The polished substrate is thermally oxidized to form silicon dioxide and silicon oxynitride, then etched in hydrofluoric acid to remove the silicon dioxide and leave a layer of silicon oxynitride 60 to 100 Å thick. The remaining steps of forming the Pt and Pt/Rh legs, attaching wires, and protective overcoating are similar to those described above for fabrication on a metal substrate, except an anneal is performed before attaching the transition wires.

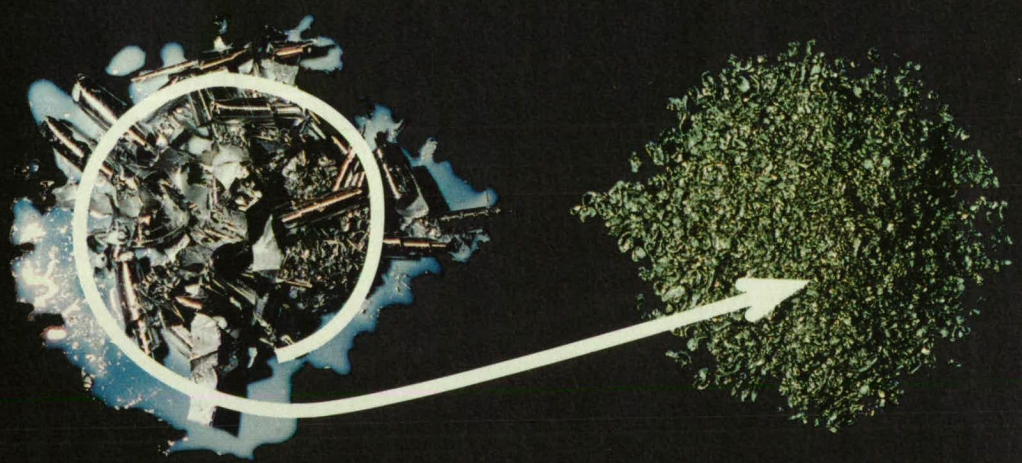
This work was done by Raymond H. Niska, Nicholas F. Schmidt, and Joseph R. Hoge of Allied-Signal Aerospace Co. for **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 145*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16437.



A **Thin-Film Type-S Thermocouple** can be fabricated on a metal or silicon nitride substrate in a multistep process. The overcoat and the ceramic cement over welded transition wires is omitted to show the complete layout of thermocouple metal parts.

Liability Asset



We provide complete systems for the handling and treatment of metal chips

Give us a call
We are open
to discuss
your needs

ALUSUISSE
ALESA

For more details
please contact
Rudy Keller at
Alesa Alusuisse Canada Ltd.

245 Victoria, Suite 700
Westmount, Quebec, H3Z 2M6
Tel: (514) 937-9105
Fax: (514) 937-0473

National Design Engineering Show

Exhibitor Profiles

This special advertising supplement features profiles of manufacturers/suppliers in the following categories that will have their products/services on display at the National Design Engineering Show, March 16-19, at McCormick Place in Chicago.

CAD/CAM
SolidWorks Corporation 4N
Unigraphics Solutions 7N
Working Model 9N
ANSYS 11N
Intergraph Corporation 12N
Enterprise Software 14N

Computers & Peripherals
Dolch Computer Systems 3N
Intergraph Computer Systems 5N
Hewlett-Packard Company 13N
Micron Electronics 15N
SL Corporation 17N
Ergotron 23N
Teknor Industrial Computers 24N

Data Acquisition
Gage Applied Sciences 18N

Electronics
SAIA-Burgess Electronics 23N

Engineering Services
ARRK Creative Network Corporation 24N
Cardinal Aluminum 24N

Fastening/Joining/Assembly Components
Penn Engineering & Mfg. Corp. 6N
Avery Dennison Corporation 19N
Belt Technologies 23N

Materials
NuSil Technology 8N

Motion Control/Positioning
Nook Industries 23N

Sensors
Data Instruments 10N
Minco Products 23N
Sensor Products 23N

Software
Invention Machine Corporation 2N
Research Systems 16N
Algor 20N-21N

Video & Imaging
RGB Spectrum 24N

Other (Industry Events)
OptiCON '98 ..... 22N

To receive information FAST from any of the companies featured in this section, use the Fast Fax Information Form on page 97.

IM-Phenomenon™
PROFESSIONAL EDITION

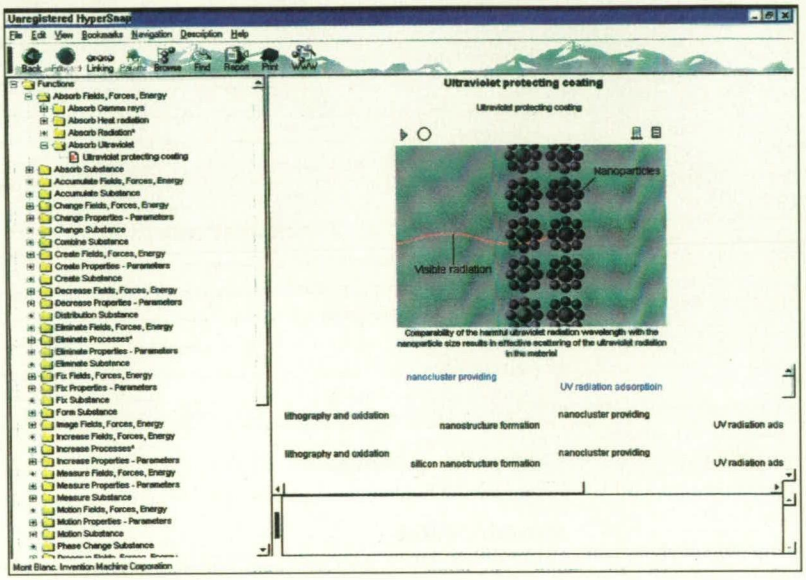
Invention Machine Corporation

In 1982, Dr. Valery Tsourikov developed the first Computer-Aided Innovation application by integrating artificial intelligence with the Theory of Inventive Problem Solving (TIPS/TRIZ).

Founded in 1992, Boston-based Invention Machine Corporation is the leading provider of software tools which enable engineers, scientists, and technologists to extend their knowledge and capability to solve technical problems by generating innovative ideas.

Invention Machine's revolutionary software tools provide users with a new approach for the development of high-quality, well-designed products and processes. Invention Machine Corporation now has offices in Sweden, France, the United Kingdom, Germany, and Japan.

With over 180 employees and affiliates worldwide, Invention Machine Corporation offers complete engineering solutions to any organization. Invention Machine offers engineering consulting and training to our clients.



Outlook

TechOptimizer™ Professional Edition is a new, innovative software tool that is designed to work with engineers in the conceptual stages of product or process development. TechOptimizer Professional Edition defines a new category of engineering software — Computer-Aided Innovation (CAI). This software tool helps users to correctly state and solve their engineering problems across a number of fields of engineering. TechOptimizer Professional Edition offers a breakthrough process for strategic and guided thinking to create innovative and cost-conscious solutions.

Creating New Concepts

Invention Machine Corporation also has another software product called IM-Phenomenon™. IM-Phenomenon Professional Edition is the first software tool that creates and analyzes new concepts.

IM-Phenomenon allows engineers to increase productivity and quickly develop entirely new products and processes. The software saves users time and money on the labor-intensive conceptual design phase of engineering. Using artificial intelligence, the software suggests and links effects, allowing users to generate innovations quickly and completely.

Benefits

Some of the benefits of Invention Machine Software include the following: enables corporations to develop innovative solutions without compromise, helps engineers to create high-quality engineering solutions, increases productivity, avoids expensive errors in the early stages of design, and stay ahead of the competition.

Partial Client List

Becton Dickinson
Electrolux
Ford
General Motors
Ingersoll-Rand
Mitsubishi Research
Motorola
Nikkei
Procter & Gamble
Raychem
Saab Scania
Sanyo Electric Co.
Sharp Corporation
Shell
Thule
Tokyo Electronic Ltd.
Toyota Motor Corp

"Having this software is like having your own personal brainstorm power."
—Michael Vaynshteyn,
Xerox Corporation

"Invention Machine has developed a software program that is being snapped up by a growing number of America's biggest companies."
—Wall Street Journal

Invention Machine Corporation
200 Portland Street
Boston, MA 02114
Tel: 617-305-9250
Fax: 617-305-9255
e-mail: info@invention-machine.com
www.invention-machine.com

For More Information Circle No. 689

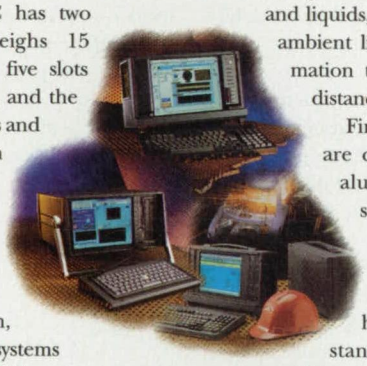
Booth #6834

Dolch: The Rugged Edge

Dolch Computer Systems, Inc. specializes in the development of rugged, environmentally hardened computer and display products for industrial, aerospace, and factory automation applications. Founded 10 years ago, Dolch has developed a family of configurable systems using off-the-shelf components innovatively packaged to offer survivability from the knocks, drops, and drips of daily real-world use.

Configurable Portable Computers

Long ago, Dolch learned that its customers wanted to take applications that ran on the desktop and port them to field-portable platforms. This meant that we had to retain the flexibility and expandability of the desktop system while dramatically shrinking the package. Each application required the platform to host some number of add-in ISA or PCI function cards and have great flexibility in the choice of peripherals, and to be rugged enough to survive field handling. To serve these needs, Dolch developed three portable systems: the LPAC, PAC, and MegaPAC. The LPAC has two add-in slots and weighs 15 pounds, the PAC has five slots and weighs 20 pounds, and the MegaPAC has nine slots and weighs 25 pounds. Each has been optimized to provide the maximum of configuration flexibility in the minimum package space.



To keep costs down, we chose to base our systems on commercially available components tailored for our use. For example, computer motherboards for Dolch are produced with controlled configurations for fabrication revision levels, assembly revision levels and BIOS revision level. Unlike common components purchased at the local computer mart, Dolch's component engineering group does not allow our vendors to change anything without a thorough evaluation of the new configuration. This process allows us to provide cost-effective solutions to our customers while providing a high-quality, configuration-controlled product that is consistent over the life span of our customers' projects.

Rugged Flat-Panel Display Systems

In 1990, Dolch was the first company to put a full-color TFT screen in a portable computer. Since then, we have been the leaders in providing new technology displays to our customers in rugged packages that survive in harsh environments. Based on this experience, Dolch has pioneered implementation of high-clarity TFT displays into unfriendly environments like the factory floor, loading docks, spindrift whipped bridges of coastal cutters, and the like.

Dolch has tackled the key problems facing information display in hostile environments, protection from shock and vibration, sealing from the intrusion of dust and liquids, viewing clarity in high ambient light, and display information transmission over long distances.

First, all Dolch monitors are constructed of aircraft aluminum or stainless steel. Critical components are shock-mounted using Iso-Guard isolators or are hard-mounted to substantial structures. This provides resistance to the shock and vibration of factory machinery or moving vehicles.

Second, multiple o-ring seals are used to provide sealing from spray, hose-down or, in some cases, immersion. Our products carry U.S. ratings of NEMA 4, 4X, and 12, and international ratings of IP54, 66, and 67. This sealing provides protection from dust as fine as that found in paper mills and from full water hosedown.

Third, Dolch has developed a series of high-bright and super high-bright backlighting systems that improve our monitors' luminance and contrast ratios to the point that these displays are visible with great clarity in direct sunlight.

Lastly, our DynaLink extension series provides long-distance remote transmission of the display data from a simple 25' to 500' analog extension to a 100-mile digital fiber optic transmission system that provides complete display clarity at the remote site while providing remote operation of a keyboard, mouse or printer.

All of these design features are directed to supplying a complete information display solution for applications in out-of-the-ordinary environments.

Worldwide Support and Systems Engineering

Dolch is established in over 30 countries throughout the world with direct company-owned locations in California, Maryland, Germany, and the United Kingdom. Each primary location can assist in specifying the exact configuration required to satisfy a customer's application, whether a standard product or a custom configuration. Twenty-four-hour support is provided through a technical support page at www.dolch.com, along with an FTP site and a problem-reporting feedback system.

Dolch believes in focusing on its niche, providing the most refined solutions for tough application in portable computing and information display. This is all we do and we strive to be the best at what we do.

Dolch Computer Systems, Inc.
3178 Laurelview Court
Fremont, CA 94538
Tel: 510-661-2220
Fax: 510-490-2360
www: www.dolch.com

For More Information Circle No. 686

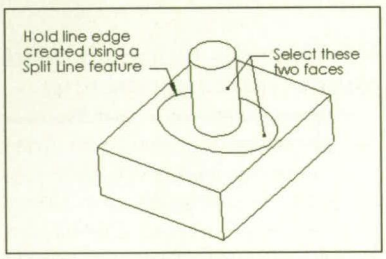
Booth 4663

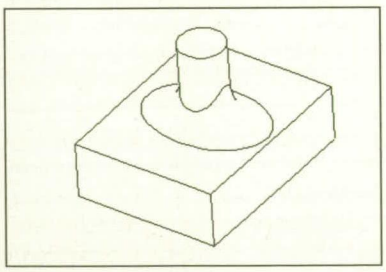
SolidWorks

SolidWorks Corporation

SolidWorks continues to extend their lead in the mainstream mechanical design market by providing exciting new functionality in SolidWorks 98. With over 100 additions to the already industry leading software, customers will get their designs to market even faster.

New features are aimed at powerful modeling and ease of use. New lofting capability allows the use of a centerline to combine the power of sweeping along a path with the flexibility of lofting through multiple sections. Swept and lofted shapes can also be made tangent to geometry at the beginning and/or end. A new fillet function allows the user to define the tangent line for the fillet and the system will create the appropriate variable radius fillet.

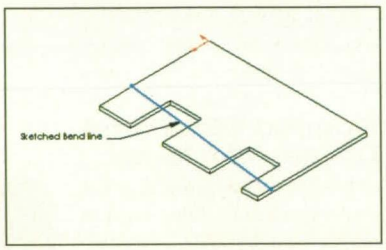


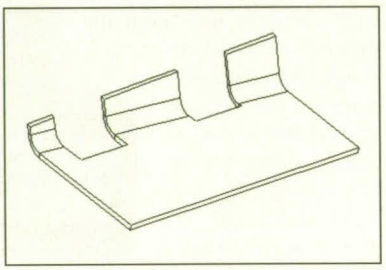


Changing your model has never been easier with the new feature handles, which allow the user to change the size, shape and orientation of a feature, just by dragging handles.

Creating features has never been easier with the extension of library features and the hole wizard. New drag and drop behavior allows easy moving of multiple features and dimensions.

New sheetmetal capability allows hems, cuts across sharp corners, and bends across multiple tabs.



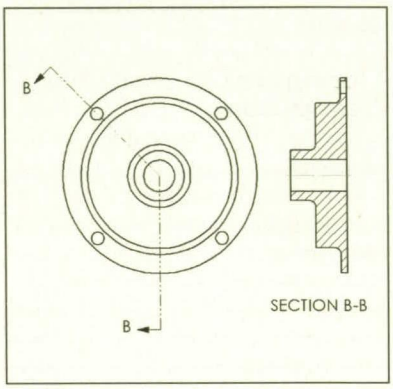


Sketching has been enhanced with the ability to cut and paste multiple entities at once. You can also add relations to multiple entities at once. The sketch filleting is now modeless and can be done with one click on a corner or a click in each curve. You can now add a point at the virtual intersection of two curves and maintain dimensions and relationships at this point. There is also an arc length dimension.

For visualization, you can now drag components while exploding an assembly for quick and easy placement. Working with large assemblies is even easier because you can select components by user-settable attributes. Components within a user-defined envelope can be hidden or displayed for easy creation of assembly configurations. Also, subassemblies can be replaced with other subassemblies. Component configurations can be specified when adding a component into an assembly.

Performance has been improved throughout the system. You can even defer the update of drawing views and assemblies when you make changes to parts. This gives the user control over when the system will recalculate views or rebuild the assembly.

Creating detail drawings is also much easier using the new dimensioning tool that shows a preview before the dimension is placed. Automatic dimension placement has also been improved, reducing the amount of drawing cleanup. OLE objects can be embedded into the template so logos can be placed right in the title block. A new rotated section view allows revolved objects to be detailed very easily.



Broken views can have multiple breaks, allowing long items to be detailed easily. New alignment tools align dimensions and maintain spacing when moved, making drawing cleanup very efficient.

These are just some of the exciting new functions included in SolidWorks 98. They are a direct result of feedback that SolidWorks has received from customers.

SolidWorks Corporation
150 Baker Avenue Ext.
Concord, MA 01742
Tel: 508-371-2910
Fax: 508-371-7303
e-mail: info@solidworks.com
http://www.solidworks.com

For More Information Circle No. 698

Booth #5079

INTERGRAPH
COMPUTER SYSTEMS

Intergraph Computer Systems

Defining Leading-Edge Graphics Performance on Windows NT

Intergraph Computer Systems is the premier supplier of workstations and graphics technology for computer graphics professionals. With a distinguished history of technological leadership, a reputation for outstanding customer service and support, and an exciting vision for the future, Intergraph Computer Systems delivers the best hardware value for the full range of CAD/CAM/CAE applications.

A History of Firsts

Intergraph Computer Systems was the first company to commit to the Windows NT operating system as the platform of choice for technical and graphics applications, in 1992. That early decision set the stage and the technical direction for a series of breakthrough innovations for graphics and technical computing on Windows NT that continues today.

Intergraph Computer Systems developed and introduced the original family of workstations on Windows NT; the premier dual-processor Intel machines; and the earliest available dual-screen systems on Windows NT. More recently, the company has delivered four successive generations of workstations that break new ground in Windows NT graphics performance.

New flagship workstations raise the performance standard. The latest workstations from Intergraph Computer Systems, the TDZ 2000 Series Graphics Workstations, outperform even the leading UNIX workstations, at a fraction of the cost. With a selection of 2D and 3D graphics options — including Intergraph-developed RealiZm II 3D graphics — the TDZ 2000 Series takes graphics professionals into the realm of graphics supercomputing on Windows NT, achieving breakthrough performance of 100+ on the CDRS-03 benchmark. With highest-performance components, leading-edge technologies, and an innovative form factor that leaves unprecedented room for expansion, the TDZ 2000 Series defines the state of the art in professional graphics workstations.

Recent Spinoff Focuses Core Strengths

In October 1997, Intergraph Corporation announced the spinoff of Intergraph Computer Systems as a separate, autonomous company. The move focuses Intergraph Computer Systems' core competencies — graphics, high-performance systems design, Windows NT, UNIX-to-NT transitions, and worldwide service and support — on the hardware challenges confronting MCAD professionals. With dedicated, focused R&D, sales, marketing, service and support, the new company is ideally positioned to accomplish its mission with an entrepreneurial attitude, the flexibility and responsiveness of a start-up company, and the freedom to form the strategic and technological partnerships required by its target markets.

Delivering the Best Performance for CAD Professionals

Intergraph Computer Systems is concentrating its core strengths to deliver superior performance and value through quality products for CAD and technical applications. These include design automation, engineering analysis and optimization, virtual prototyping, visual simulation, and computer-aided manufacturing. With an aggressive strategy for the CAD and manufacturing community, Intergraph Computer Systems projects exceptional growth for 1998, and is tooling up its manufacturing, distribution, and service and support infrastructure to accommodate the ambitious growth plan.

Intergraph Computer Systems
Huntsville, AL 35894-0001
Tel: 800-763-0242
Fax: 205-730-6188
www.intergraph.com/ics

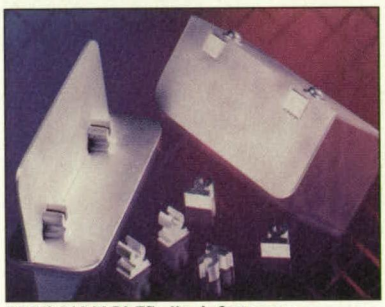
For More Information Circle No. 690

Booths 6829, 6838

PENN ENGINEERING & MANUFACTURING CORP.
DANBORO, PENNSYLVANIA 18916-1000 USA • PHONE: 215-766-8853 • FAX: 215-766-3634

Penn Engineering & Manufacturing Corp.

Today, more than 56 years after Penn Engineering was founded, we offer hundreds of types of fasteners in thousands of variations and ship billions of pieces each year. For the aerospace industry, our fasteners are specified to meet the component-assembly requirements of smaller/lighter designs, tighter space, fewer parts, fewer assembly steps, faster assembly times, design for serviceability, less cost, and enhanced reliability. All these trends have spurred Penn Engineering to continually innovate, invent,



PEM® R'ANGLE™ clinch fasteners

develop, and design fastening solutions that keep pace with the next generation of end-product. In the past year alone, a half-dozen new fastener types have been introduced by Penn Engineering and represent the latest advancements in fastening technology. These include:

• **PEM® R'ANGLE™ Right-Angle Clinch Fasteners.** These new fasteners are uniquely designed to provide a strong right-angle attachment point in aluminum sheets as thin as .040 in/1 mm and offer a cost-effective alternative to bent tabs at edges of sheets; bent tabs in the middle of sheets; bent flanges; right-angle brackets; tack welds; and loose hardware. Benefits in using a PEM R'ANGLE clinch fastener (Type RA™) include more predictable designs and tighter design control, no more tab cutouts (better EMI/RFI shielding), material and assembly cost savings, reduction of loose hardware, more attractive panels, and elimination of welding.

• **PEM® Self-Clinching Panel Fasteners.** Type PF11™ panel fastener assemblies are designed to ensure quick panel removal and eliminate the risks associated with loose hardware. These panel fasteners feature a large knurled knob with a combination slot/Phillips drive to allow for finger or tool operation. A distinct shoulder feature provides a positive stop when the fastener is installed.

• **PEM® Flush-Head Studs.** New Type FH4™ self-clinching flush-head studs can be used in stainless steel sheets as thin as .040 in/1 mm. Upon installation in metal assemblies, these studs create a flush-head assembly and lock securely with high torque-out and pushout resistances.

• **PEM® Self-Clinching Threaded Standoffs.** Upon installation in sheets as thin as .025 in/0.63 mm, Type TSO™ (steel), Type TSOS™ (stainless steel), and Type TSOA™ (aluminum) self-clinching standoffs deliver high pushout and torque-out resistances. These new fasteners provide permanent threads in ultra-thin aluminum or steel sheets to enable stacking or spacing PC boards and other components.

• **PEM® Self-Clinching Pilot Pins.** New Type TPS™ pins are designed to satisfy a wide range of alignment, positioning, and pivot applications. When installed,

New from Penn Engineering: PEM® Type TPS™ Pilot Pins

these stainless steel studs maintain a flush appearance on the reverse side. The chamfered end of the pin makes locating attached parts for alignment or mounting quick and easy.

• **PEM® Self-Clinching Studs.** New Types FHL™ (steel) and FHLS™ (stainless steel) self-clinching studs will be introduced at this year's NDES for close-to-edge and minimum space assembly applications. Compared with standard studs, the head of this fastener is designed with a smaller diameter and

New from Penn Engineering: PEM® Type FH4™ Studs for Stainless Steel

the overall fastener size is likewise smaller to allow for installation in confined spaces. These fasteners install closer to the edge of a sheet than standard studs without causing that edge to bulge.

As these new fasteners demonstrate, fastening needs continue to evolve. Our mission is to remain the industry pioneer ... meeting design challenges and delivering fastening solutions and the benefits that result.

Penn Engineering & Manufacturing Corp.
5190 Old Easton Road
Danboro, PA 18916-1000
Tel: 800-237-4736
Fax: 215-766-0143
e-mail: pem@pemnet.com
www.pemnet.com

For More Information Circle No. 687

Booth #7106

INTERGRAPH
SOLID EDGE™

Solid Edge™ Has United With Unigraphics Solutions to Offer a Full-Featured Mechanical CAD Product Family

Unigraphics Solutions, Inc. has recently added Solid Edge to its Unigraphics, Parasolid, and IMAN product families to offer you a suite of scaleable products from mid-range to high end. Solid Edge Version 5, based upon Parasolid core modeling technology, will be available in May. There are more CAD/CAM seats using Parasolid in production than any other alternative solid modeling engine.

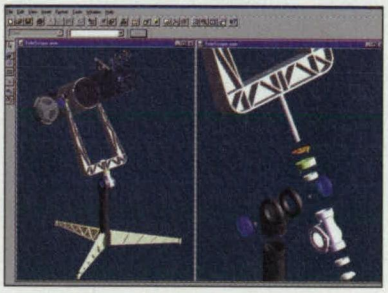
Solid Edge is the mechanical CAD system that is helping designers and engineers all over the world conquer challenges today that will shape our tomorrow. Solid Edge is an affordable, feature-based solid modeler and an associative drafting system, with strong assembly design capabilities for companies designing machinery, manufacturing equipment, and mechanical design components for companies with strong ease-of-use requirements. Solid Edge includes many productivity enhancing tools that are available only as extra-cost add-ons with other CAD systems.

A highly-motivated Solid Edge development team, located in Huntsville, AL, continues to apply a disciplined methodology to develop the Solid Edge product. This team consists of focused developers with years of commercial solid modeling experience, as well as advanced technical degrees — directed by an industry-recognized management team. The Solid Edge development process is ISO 9001-certified as of September 1997.

Production Solid Modeling

Solid Edge's parametric, feature-based solid modeling is developed specifically for mechanical design professionals, so it works the way designers think. You can use powerful, intuitive design tools to easily model virtually any mechanical part or assembly in full 3D solid geometry. Solid Edge's robust feature toolkit includes cutouts and protrusions (i.e., revolved, swept, lofted, and helical), hole features, thinwalls, rounds, and patterns to simplify and accelerate modeling, even for complex operations.

With Solid Edge, new parts can be modeled from within the assembly model, using the geometry of neighboring components to ensure accurate fit and function. Solid Edge supports both this top-down approach and a bottom-up design technique, and provides streamlined revision and configuration tools that simplify development of large assemblies. Multiple designers can work concurrently on the same assembly with immediate access to each other's current design work.



Streamlined Sheet Metal Design

Solid Edge includes a unique modeling environment tailored for sheet metal components. This environment is fully integrated with assembly, design, drafting, and data management capabilities to help reduce design time for products that include sheet metal components. All commands and functions in the Sheet Metal environment use terminology familiar to the sheet metal design industry: tabs, flanges, flat patterning, bend and corner relief, and unbend/rebend.

The Industry's Best Mechanical Drafting System

Whether you are working from a solid part or assembly model, or even starting from scratch, Solid Edge helps you create drawings faster with the most streamlined CAD drafting tools available. Solid Edge Drafting is a low cost, standalone 2D drafting package with all of the ease-of-use features and productivity advantages of Solid Edge.

A native Windows application, Solid Edge brings high-performance solid modeling to the familiar Windows environment. As the first mechanical solid modeling software to gain official designation as Office 97-compatible, Solid Edge assures designers that their CAD system looks like and works well with familiar Windows word processing, spreadsheet, database, presentation graphics, world wide web, and e-mail packages.

Solid Edge includes interactive multimedia tutorials, covering both basic and advanced topics, that help you build CAD proficiency at your own pace and dramatically reduce learning curves.

Better CAD Value

Compared to PC-based, value-priced systems, Solid Edge delivers industrial-strength modeling functions and a superior migration path to full 3D solid-based design. Solid Edge's high-end performance is available at a fraction of the cost of traditional high-end CAD, and with a fraction of the training and implementation costs of these typically complex systems. You can recover your initial investment in a shorter time, realize increased design productivity sooner, and reap greater cumulative annual gains with your investment in Solid Edge.

Unigraphics Solutions®
An EDS Company

Unigraphics Solutions, Inc.
Tel: 800-807-2200
Fax: 205-730-1053
e-mail: solidedge@ugsolutions.com
www.solid-edge.com

For More Information Circle No. 697

Booths 6829, 6838

NuSil Technology

Since 1979, silicone technology has been NuSil Technology's singular focus. Dedicated to development, manufacturing, and technical service, NuSil Technology has earned the reputation as the leading supplier of silicone solutions for specific design problems encountered in aerospace, health care, and other high-technology industries.

Products

NuSil Technology is a basic manufacturer, synthesizing silicone monomers, catalysts, crosslinkers, resins, and polymers used in over 400 custom and standard formulated products. These products include:

- adhesives
- elastomers
- dispersions
- fluids
- gels
- lubricants
- coatings
- abrasion-resistant elastomers
- liquid silicone rubbers
- inks
- primers

Quality

Safety, reliability, and traceability are the constant concerns of NuSil Technology's Quality Assurance Department. This department works together with the R&D, Engineering, and Sales Departments to provide guidelines for development, production, reliability, and inspection of all silicone materials manufactured at NuSil Technology.

NuSil Technology is an ISO-9001 certified company. This ongoing commitment to quality assures that the systems, services, and products from NuSil Technology are consistently meeting the high standards of the ISO-9001 requirements.

Facilities

NuSil Technology's corporate offices and over 100,000 square feet of multiple modern manufacturing facilities are located in Carpinteria, CA near Santa Barbara. Located in Anglet, France, is NuSil Technology's European headquarters. This office provides sales and marketing services for the European community.

Technical sales and services are handled direct in most cases. Representatives and distributors are available in some areas.

NuSil Technology
1050 Cindy Lane
Carpinteria, CA 93013
Tel: 805-684-8780
Fax: 805-684-2365
www.nusil.com

For More Information Circle No. 684

Booth #8542

Working Model, Inc.

Cut, Fall, and Load

A Washington forestry equipment manufacturer makes labor-saving machine possible with SolidWorks '97 and Working Model 3D software.

Imagine a single machine that could revolutionize forestry by cutting and felling a tree, stripping its limbs, and placing it on a truck for shipping in minutes. This unlikely device, called a cut, fall, and load (CFL) grapple, wasn't lifted from the pages of a logger's fantasy. It is becoming reality in the Washington headquarters of forestry equipment manufacturer Danzco with the help of SolidWorks and partner software from Working Model, Inc.

Danzco's cut, fall, and load system, which debuted at the Pacific Logging Congress' outdoor show on September 18, 1997, is a forest industry first. "We've wanted to put together a CFL system for a long time," said Ed Danzer of Danzco. "But until we had a software solution that enabled us to reduce weight significantly in the design stage, CFLs were doomed to be too heavy for practical use."

How to Design Fast and Light

To make the first-ever CFL light enough to move around the forest floor and durable enough to survive a rugged logging environment required Danzco to consider every conceivable weight-saving measure and calculate its effect on durability. "It's like developing a high-performance fighter plane that can take a lot of shots, too," explained Danzer. "But that takes a lot of calculations and innovative engineering throughout the machine."

Danzco also needed to engineer high quality into the CFL to minimize warranty costs over the course of the CFL's product life. "Our CFL line will probably sell about 400-500 units in its first four years," said Danzer. "With those kind of numbers, we can't amortize warranty costs over a large volume. The product has to be as close to perfect as possible when it leaves the factory."

Because money and time constraints prohibited Danzco from using a physical prototype for design tests, Danzco required a design and analysis software solution that could accurately capture design revisions, calculate the effects of material configurations on weight and performance, and simulate the CFL's functions in reaction to numerous design iterations. That feat was accomplished with a solution mating SolidWorks '97 with Working Model 3D v2.0 motion analysis software from Working Model Inc., and COSMOS/Works for finite element analysis.

Desktop Creation

Danzer created the basic geometry and solid models of the CFL in SolidWorks '97. As a long-time user of SolidWorks, Danzer was thrilled by the improved user friendliness and stability of the software.

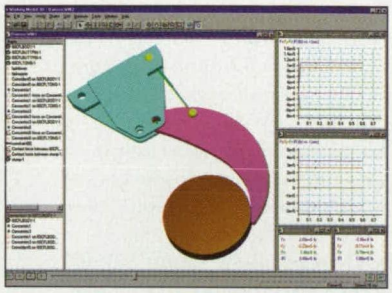
"The greatest software in the world isn't worth anything to me if it's hard to use and hard to learn," said Danzer. "SolidWorks and Working Model don't have steep learning curves and are very stable. We consider our design software to be tools, and if we had to spend more time learning how to use our tools rather than applying them, our operational costs would skyrocket."

SolidWorks and Working Model also save Danzco money by providing an affordable foundation for their design solution. "As a Windows-based software, SolidWorks and Working Model enable us to use common desktop hardware we can afford. You get a lot of bang for the buck and we save a ton on development and operational costs," stated Danzer.

Communicating the Complex, Imagining the Impossible

Danzco also takes advantage of the improved design communication that both SolidWorks '97 and Working Model 3D make possible. "With SolidWorks, we can communicate designs to a customer in a way we never could before. When you can show a customer how a project will turn out in its earliest stages, you're more likely to get the approval that moves a project along faster."

Along with finite element analysis software, SolidWorks '97 and Working Model 3D are enabling Danzco to consider design possibilities at a greater rate



than ever before, meaning faster design cycles. But SolidWorks '97 and Working Model 3D also help eliminate the materials waste that accompanies destructive testing of prototypes. As Danzer explained, "Before Working Model, an engineer made a lot of educated guesses about whether a design would work. Sometimes those guesses are wrong, but when you're working on the prototype of a limited production item like a CFL, you can't afford to guess wrong. With Working Model, we can do a thorough analysis of a mechanism without blowing anything up."

Though SolidWorks and Working Model have helped Danzco achieve enormous savings in time and resources, the software has also lent a more important luxury to Danzer and his team of engineers: the time and flexibility to imagine and consider the impossible. "The greatest benefit of using SolidWorks and Working Model is that we have the ability to do things we've never done before," explained an excited Danzer. "We're opening markets that never existed and for now we're all alone on top. That's a nice place to be."

Working Model, Inc.
A Division of Knowledge Revolution
66 Bovet Rd., Ste. 200
San Mateo, CA 94402
Tel: 650-574-7777
Fax: 650-574-7541
www.workingmodel.com

For More Information Circle No. 680

Booth #6822

DATA INSTRUMENTS

Data Instruments Inc.

Data Instruments is a multinational corporation with five major business units centered around such core areas as electronic sensors, transducers, and controls.

- Transducer Products Group: Position-sensing transducers and potentiometers, and stainless steel pressure transducers
- Advanced Silicon Group: Silicon-based micromachined pressure sensors
- Critical Fluids Group: Pressure measurement products for high-purity fluids used in electronics fabrication
- Detector™ safety light curtains for machine guarding
- Wintriss® Controls Group: Press automation, die protection, and safety controls for metal stamping.

Historical Background

Data Instruments is an employee-owned company with some 500 employees, subsidiaries in Europe and Japan, and a global network of sales and service representatives. It was among the first U.S. companies to achieve ISO 9001 certification, the strictest of the ISO standards. Although Data Instruments was officially incorporated back in 1977, our lineage dates back at least 50 years. It's a

Data Instruments' corporate headquarters in Acton, MA.

pedigree that includes the industry pioneers who created and perfected the technology as we know it. Our ranks include individuals recognized throughout the industry for their contributions to the state of the art (some have been with us for 40 years or more). Our original patents date back 50 years.

When we started making transducers, each was hand-crafted at a cost that limited their use to aerospace or military applications. Since then, we've introduced design innovations and manufacturing refinements that allow us to meet the most demanding requirements at a fraction of their former cost. Today, we produce hundreds of thousands of high-quality transducers a year in our ISO-9001-certified manufacturing facilities in Acton, MA and Sunnyvale, CA. Millions currently are performing in continuous-duty applications around the globe. Typically they outlast the systems they support.

Position-Sensing Transducers

Our linear and rotary position-sensing transducers include a wide range of contact and noncontact position sensors employing both potentiometric and inductive technologies. Standard stroke lengths range from 0.5 to 60 inches. Our linear potentiometers are rated intrinsically safe. They're also CE-rated. Our potentiometers are a cost-saving, space-saving alternative to LVDT and magnetorestrictive devices. For example, DC Hydrastar® has the largest usable body-to-stroke-length ratio of any noncontact, incylinder position sensor available. DI position transducers offer a choice of high-level DC, current, or voltage output.

Stainless Steel Pressure Transducers

The unique design of our stainless steel pressure transducers has elevated quality and reliability well beyond accepted standards. Our bonded semiconductor strain-gauge technology and stainless steel diaphragms withstand the harshest conditions, including corrosive media. Laser-trimmed and tested, they are fully calibrated and temperature-compensated to assure long-term reliability and accurate performance. DI stainless steel pressure transducers can survive more than 160 million full-pressure cycles and still retain their rated accuracy. They are available in gauge, absolute, sealed, and differential models for pressure ranges from 0-5 to 0-20,000 psi.

Micromachined Silicon Pressure Sensors

DI's silicon-based micromachined pressure sensors are low-cost miniature sensors with ranges from 1" H_20 to 150 psi. Small enough to mount directly on printed circuit boards, they're ideal for applications ranging from OEM medical and environmental instrumentation to respirators, cleanrooms, and HVAC equipment. The Sursense™ models employ proprietary DSC (Dynamic Self Compensation) technology for very low pressure ranges of 0-1, 0-5, 0-10, 0-20, and 0-30" H_20. They can be mounted in any position, because they're not position-sensitive. DSC also eliminates offset errors due to long-term drift.

Detector Safety Light Curtains

Detector light curtains prevent injury by shielding operators and passersby from machine hazards with a harmless and invisible curtain of infrared light beams. Any intrusion signals the machine to stop. Our light curtains have been protecting people for over 25 years. With tens of thousands installed, we're the acknowledged leader in industries known for having some of the world's toughest safety standards.

Global Network

With our global distribution network and technical centers in Germany, France, and Japan, you can expect applications assistance, on-time delivery, and in-depth support virtually anywhere in the world.

Data Instruments Inc.
100 Discovery Way
Acton, MA 01720
Tel: 800-333-3282
Fax: 978-263-0630
www.datainstruments.com

For More Information Circle No. 681

Booth #7673

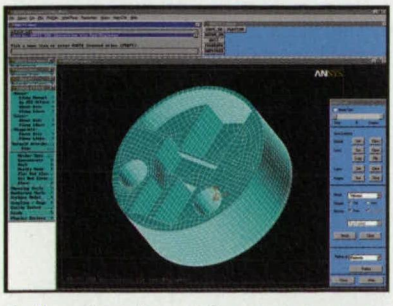
ANSYS®

Simulating Real Life: Software with No Boundaries

Companies today face a unique set of challenges, such as manufacturing quality products faster, ensuring interoperability of multiple software applications, and providing easy access to engineering data in multiple locations. For companies managing change in a complex environment, issues such as these can create boundaries that hinder productivity and the ability to get products to market first. The ANSYS and DesignSpace Enterprise product lines help engineering organizations address these and other challenges by breaking down these boundaries.

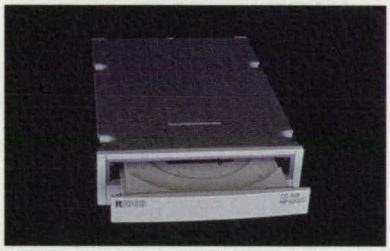
DesignSpace Enterprise provides access to design data on every level. It bridges the gap between CAD and CAE by allowing design engineers to leverage the power of ANSYS technology early in the design phase. Companies save time and money by moving analysis capabilities up-front in the product development cycle, avoiding unnecessary prototype testing cycles and last-minute engineering changes.

DesignSpace Enterprise offers users flexibility by working effectively with all leading CAD systems, making it easy to leverage data from various software applications. The ANSYS family of products extends this flexibility further through support of all major hardware platforms, a consistent graphical user interface, and compatible data structure. Companies benefit from a complete set of tools for their entire enterprise, from designers and engineers to



dedicated analysts and managers, meeting needs throughout the engineering continuum.

The ANSYS family of products offers users the greatest breadth of multiphysics analysis capabilities for solving highly complex problems. With ANSYS coupled-field capabilities, engineers can examine the effects of a single or multiple physical phenomenon interacting, allowing them to solve real-world challenges. In addition, DesignSpace Enterprise offers users the greatest breadth of geometry transfer capabilities through several tools that facilitate the



Ricoh's newest rewritable optical disc drive. This model occupies less than 40 percent of the space of an earlier model.

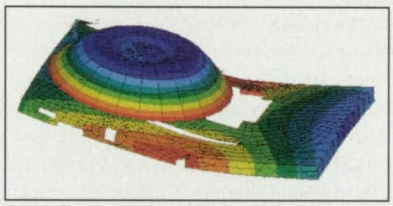
enterprise-wide sharing of data. By tearing down the traditional boundaries between design and analysis, ANSYS enables cross-functional teams to work together in a highly collaborative and interactive way throughout the design-to-manufacturing process.

ANSYS support distributors are strategically located all over the world to offer customers local services, consulting, and support in any geographical location. Our sales channel delivers complete engineering solutions to help customers improve their business processes and increase productivity by offering a comprehensive product line, training, and services.

Electronics Packaging Industry

An increasing number of electronics companies now find the use of computer-aided engineering (CAE) tools essential to the success of their products. ANSYS offers comprehensive engineering solutions for the electronics industry, making it invaluable to this fast-paced, highly competitive marketplace.

Because of the flexibility of ANSYS technology, it provides CAE tools that can benefit electronics companies in a wide range of areas. Structural and thermal analyses are among the traditional electronics simulations performed by companies throughout the electronics industry on an ongoing basis. In addition, the electronics industry relies on current conduction, computational fluid dynamics (CFD), and coupled-field analyses to design products. Manufacturers of electromechanical devices



One of several plots Ricoh used to analyze the disc drive mechanism's harmonic response to vibration caused by an uneven surface of the optical disk.

such as motors, solenoids, and transformers depend on electromagnetic, structural, thermal, and acoustic capabilities. ANSYS, Inc. offers electronics solutions in all these areas to companies on a worldwide basis.

The ANSYS family of products is a comprehensive suite of design analysis and optimization tools providing companies with wide reaching engineering capabilities. ANSYS software's unique multiphysics capabilities enable companies to address specialized electronics applications ranging from microwave design and analysis to component heat transfer to hard disk drive simulation to speaker acoustic analysis.

ANSYS, Inc.
Southpointe
275 Technology Drive
Canonsburg, PA 15317
Tel: 724-746-3304 or 800-WE-R-FEA-1
Fax: 724-746-9494
http://www.ansys.com

For More Information Circle No. 696

Booth #5075

INTERGRAPH

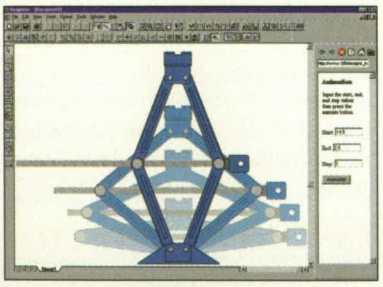
Imagineer™ Technical 2.0

The easiest precision design tool for engineering professionals.

Cutting design time without sacrificing quality is a goal of many design engineers who are faced with the daily pressures to shorten their design cycles and produce more, faster. With unparalleled ease of use, Intergraph's award-winning Imagineer™ Technical sets a new standard for CAD usability for designers and engineers by giving them a smart sketching tool that allows them to draw as they think.

Developed specifically for Microsoft Windows® 95 and Windows NT®, this innovative program not only signals a new era in affordability and productivity, it also interoperates with other technical and business software applications. A powerful 2D precision design drawing program, Imagineer is the ideal engineering "think tool" for everything from quick sketches to complete 2D mechanisms.

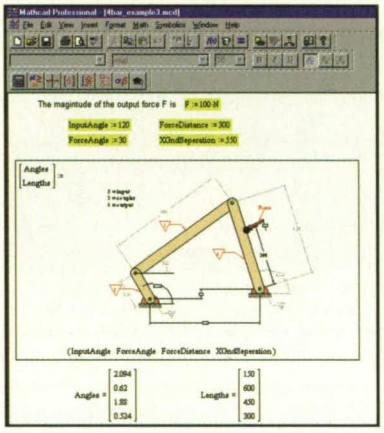
Right out of the box, Imagineer functions as a natural extension of the design engineer's thought process, eliminating the command clutter and complicated operating procedures generally associated with traditional high-end CAD applications. With Imagineer, users can accomplish more, in less time, with fewer mouse clicks, commands, and pull-downs. This means the design engineer



Imagineer Technical's mechanism modeling and 2D kinematic animation capabilities allow designers and engineers to explore "what if" scenarios and test their designs onscreen.

can spend more time refining his or her design, greatly reducing the need for costly physical prototypes and ultimately resulting in a better design.

Nicholas DeMarco, a quality assurance manager and designer for Lida Manufacturing Corporation, was thrilled to finally find a powerful, yet intuitive precision drawing tool. DeMarco sums up the design engineer's quandary: "I know in my head what I want a design to look like, and I want to get the design into a computer model or on paper with as little interference as possible. With most CAD products, getting ideas from



Imagineer can be used with Mathcad 7 Professional to analyze mechanical systems, verify engineering designs, and automatically generate designs that conform to specifications.

my head to the computer was a problem because their non-intuitive aspects were always getting in my way. The difference between Imagineer and other CAD products is that Imagineer is simple to use. It doesn't get in my way."

"Smart" Features

Designed by an expert team of mechanical and computer engineers, Imagineer's ease of use is equally matched by its power. Created especially with the design engineer in mind, Imagineer's unique and powerful "smart" drawing capabilities make precision graphics amazingly simple.

With Imagineer's Smart Relationships feature, for instance, users can define and maintain relationships between elements. Imagineer generates intelligent geometry that both "understands" its own constraints and "remembers" its relationship with other geometry.

While the concept of setting relationships may seem foreign at first, this unique feature ultimately proves to be an indispensable time-saving tool. As Scott Marti, President of Precision Products and Machinery says, "Relationships .... that was a new concept to me ... When a drawing's made with relationships, you can actually go in there and basically just enter the dimensional change, and the drawing will correct itself and be ready to be put on the shop floor, rather than having to edit both the drawing and the dimension."

Creating precision designs is a snap with Imagineer's SmartSketch™ feature which provides the design engineer with instant visual feedback. Plus, designs can also be driven from a variable table or an Excel spreadsheet or linked with formulas in Mathcad 7® Professional. And its mechanism modeling and 2D kinematic animation capabilities allow designers and engineers to explore "what if" scenarios and test their design models onscreen.

Further setting this product apart is its unparalleled ease of use. Thanks to its intuitive Windows interface, Imagineer requires little or no formal training. Moreover, Imagineer was designed to "think" along with the engineer. Commenting on Imagineer's intuitiveness and ease of use, Scott Marti says, "The program works more like I do than anything else I've tried. It matches my design thought process!"

Imagineer Technical — created *for* design engineers *by* design engineers. It's powerful, easy to use, and priced to fit on every engineer's desktop!

Intergraph Corporation
One Madison Industrial Park
Huntsville, AL 35894-0001
Tel: 800-292-9761
www.intergraph.com/imagine

For More Information Circle No. 670

Booth #6359

HEWLETT® PACKARD

Meeting the Challenge of Change

Customers agree that managing constant change is a challenge that many enterprises are simply not meeting effectively. Shifting business strategies are often not reflected in the product design cycle as quickly as needed. Enterprise information is fragmented, hard to access. The objectives and goals of the IT, product development, and manufacturing organizations within the enterprise don't line up.

Hewlett-Packard makes it easy to manage change. HP works with its customers to build a foundation that supports the business strategy, integrates new business and engineering processes to ensure alignment, secures a sound but flexible information base, leverages the best of new technologies, and protects the enterprise's investment with a forward-looking commitment to innovation, integration, and solution implementation.

And that foundation is built on a combination of the world's best UNIX and Microsoft Windows NT-based platforms — systems that work together to provide a highly productive and powerful synergy that benefits users at all levels in even the biggest engineering enterprises.

On the Right Track to Success

But the proof is in the bottom line. HP design and engineering teams work closely with customers like Benetton Formula Ltd. to keep them on track in highly competitive situations. A leading maker of Formula 1 cars, Benetton designs a new car every year, continuously fine-tuning it during the racing season.

Benetton engineers have standardized their most demanding 3D modeling on high-performance HP UNIX systems, while accessing Wintel applications via an NT server — creating a highly efficient enterprise-wide mix of platforms. "We chose HP as a trusted advisor [because] they have expertise in both UNIX and NT enviroments, plus a clear roadmap to the integration of both technologies on a single platform in the future," says Benetton IS manager, Debbie Edwards. "HP consultants not only have in-depth knowledge of their own platforms and specific design tools, but are also well versed in products for networking, communications, UNIX and NT interoperability, and product data management." Clearly a formula for success.

Upping the Ante

HP's leadership is the result of combining powerful, high-performance workstation and server platforms that function in both UNIX and NT operating environments with industry-leading technologies for enterprise productivity. These technologies include a full suite of Internet management products, the HP OpenView family of solutions to ensure network and system readiness, and collaborative technologies such as HP Shared 3D viewer.

It all adds up to complete solutions, to an extent unrivaled by any other workstation manufacturer, from the clear leader in technical computing. In fact, International Data Corp. (IDC) reports that HP leaped past the competition to become the leading company in the workstation market, based on 1997 shipments of UNIX- and Windows NT-based systems.

Whatever the challenge, HP delivers real solutions to manufacturing companies' needs.

For more information on HP's products and services for engineering enterprises, see http://www.hp.com/go/technical — from there, search on "Benetton" for more on the HP-Benetton partnership.

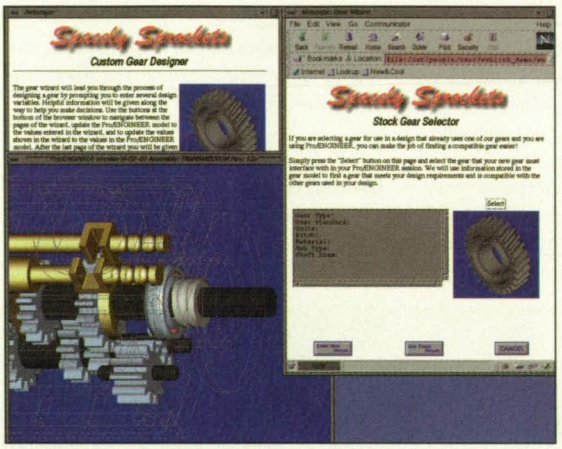
Hewlett-Packard Company
3000 Hanover Street
Palo Alto, CA 94304-1185
Tel: 650-857-1501
Fax: 650-857-5518
www.hp.com

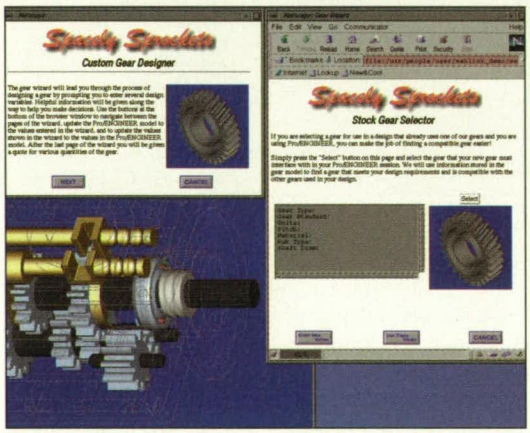
For More Information Circle No. 671

Enterprise Software Products, Inc. (ESPI)

Company Overview

Enterprise Software Products, Inc. (ESPI) was founded in 1985 with the vision of providing easy-to-use and cost-effective modeling and visualization software for organizations using finite element analysis (FEA). The company's founders hail from the aerospace industry, where they gained expertise in the areas of advanced computer hardware and traditional high-end analysis software such as MSC/NASTRAN and SDRC's I-DEAS products. With this first-hand experience, the founders created the company's flagship product line, FEMAP, to offer powerful finite element analysis (FEA) technology as a powerful, yet economical solution for today's PC-based engineering environment.





More than 8,000 commercial FEMAP licenses worldwide in the aerospace, automotive, consumer goods, electronics, industrial machinery, and process industries are using the technology to shorten development cycles and add value to existing investments in CAD/CAM/CAE systems. Globally competitive customers that testify to FEMAP benefits include AlliedSignal, Bayer, Boeing, DuPont, Fujitsu, Goodyear, Mitsubishi, NASA, NEC, Siemens, United Technologies, and Xerox.

In addition to the FEMAP product line, ESPI also maintains a successful original equipment manufacturer (OEM) program, whereby providers of engineering software can develop and market integrated applications which utilize FEMAP technology for analysis modeling and visualization. Currently there are more than 20 third-party applications, comprising more than 4,000 commercial software licenses with FEMAP integrated as the analysis visualization tool.

Product Highlights

FEMAP launched in 1986, and today the product is a fully native Windows application written in the object-oriented C and C++ languages. Customers using FEMAP agree that the technology is easy to learn and use, and it allows them to leverage existing investments in hardware and software. These advantages allow engineering organizations to reduce cycle time and save money. From the technical perspective, FEMAP provides a variety of benefits, including:

- comprehensive finite element modeling
- flexible results evaluation
- extensive, high-quality support for a range of finite element solvers such as ABAQUS, ANSYS, and NASTRAN
- robust access to CAD data
- geometry modeling focused on the analysis user
- breakthrough speed in automatic meshing and graphics

FEMAP offers Dual Engine Geometry Modeling that integrates both the ACIS and Parasolid geometry kernels with FEMAP. This broad functionality allows users the flexibility to access geometry from many leading CAD systems, including Solid Edge, SolidWorks and Unigraphics. FEMAP also offers robust geometry import for Pro/ENGINEER, I-DEAS Master Series, CATIA, and other systems.

Breakthrough graphics speed enables users to instantly visualize results on the desktop. As a native Windows product, Word, Excel, PowerPoint and other business applications can be imported into FEMAP to create dramatic presentations and graphically communicate design status, analysis results, and project progress. Successful manufacturers such as The Boeing Company, Mitsubishi, and Siemens rely on FEMAP to integrate multiple solver technologies in a single modeling and visualization environment.

Enterprise Software Products, Inc.
415 Eagleview Blvd., Suite 105
PO Box 1172
Exton, PA 19341
Tel: 610-458-3660
Fax: 610-458-3665
www.femap.com

For More Information Circle No. 692

Booths 6829, 6838

MICRON ELECTRONICS™

We Design Innovation

The Big Difference

Micron Electronics is a respected and recognized leader in the innovative design, development, and manufacture of world-class computer products.

At Micron, we are firmly rooted in a unique tradition that blends high-tech manufacturing know-how with an expertise in the design and development of innovative products. No other PC company has this in-depth understanding of the core technology used in its products.

This technical proficiency is derived from the legacy of our parent company, Micron Technology, Inc. They've been a leader in innovating memory chip design and manufacturing for nearly 20 years. That kind of clout, coupled with our commitment to excellence, allows us to manufacture award-winning technical workstations you can count on.

The World-Class Workstation

A new class of technical workstations has emerged on the scene. The stand-out performer among these Pentium® II/Windows NT®-based systems is the Micron™ Powerdigm™ workstation.

The Powerdigm system marks a dramatic shift in the way the computing industry thinks about workstation design, offering a refinement and an extension of existing computer technology to incorporate the strengths of PCs and workstations. Like its PC counterparts, the Powerdigm workstation integrates industry-standard Intel processors and the Windows NT operating system, letting the user take advantage of a wide selection of more cost-effective technologies. And like the proprietary workstations, it supports multiple processors and high-end peripheral devices, such as OpenGL 3D accelerators and graphics coprocessors.

Along with implementing the best design characteristics of existing PCs and traditional workstations, the Powerdigm provides a revolutionary development in core technology. With its innovative Samurai™ chip set, the Powerdigm workstation achieves higher performance levels than those possible with competing chip set technologies. Best of all, you can run your everyday business applications, too. Based on industry standards, the Samurai technology is the first fully Intel-compatible chip set to offer a 64-bit/66 MHz PCI solution. Thanks to its high-powered Samurai core technology, the Powerdigm workstation easily handles your most demanding CAD/MCAD, EDA, and GIS projects.

Everything You Want and Need

In conjunction with the Samurai chip set from Micron, the performance of the Powerdigm workstation is derived from the Intel Pentium II processor. The most recent and most powerful processor available from Intel, the Pentium II has empowered the development of high-performance workstations based on industry standards. Running at speeds up to 333 MHz, the Pentium II processor paves the way for design and engineering professionals to enjoy the benefits of a robust and agile platform that's completely Windows NT-compatible. The Pentium II processor is the ideal engine to drive CAD/MCAD, EDA, and GIS applications, delivering superior scalability, manageability, and cost-effectiveness essential for businesses to compete.

The Powerdigm workstation also provides you with an impressive selection of high-end tools for 3D graphics with 100% Windows NT OpenGL-compatible accelerators. Diamond Multimedia's Fire GL series of accelerators delivers professional-quality 2D/3D performance for power-hungry applications.

The Powerdigm workstation comes

configured with Windows NT Workstation 4.0. With a comprehensive feature set that provides the necessary reliability, manageability, security, networking, and performance capability for today's enterprise, Windows NT offers one of the most powerful 32-bit desktop operating systems available. Its multithreaded, multitasking architecture is designed to run 32-bit Windows-based applications more reliably and securely than competing Windows operating systems.

Integrating the revolutionary new Micron Samurai chip set technology with the advanced Pentium II processor and Windows NT operating system, the Powerdigm workstation delivers unbridled performance for the most resource-intensive applications of today's engineers and designers.

Call now to order.
888-669-0971
www.micronpc.com

MICRON ELECTRONICS™

Configured For Your Life™

For More Information Circle No. 673

Research Systems

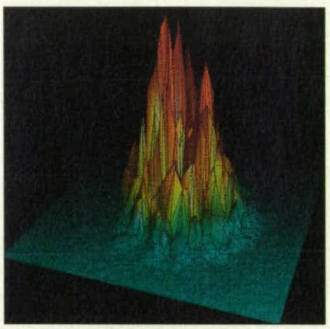
Software ≡ Vision

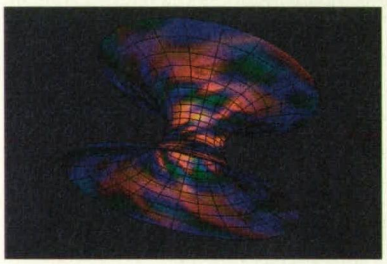
Research Systems is dedicated to creating the best analysis, visualization and application development software to help scientists and engineers minimize programming and gain deeper insight into their data. Founded in 1977 by David Stern, Research Systems has grown steadily to more than 90 employees, with an emphasis on building a team whose expertise complements the work of its users. Stern began RSI when he realized the need for a software language that allowed scientists to test hypotheses without employing a programmer every time they needed to write or modify a data analysis application. The fourth-generation software language IDL®, the Interactive Data Language, was born from that concept. Scientists, engineers and researchers quickly recognized IDL as a fresh, practical new method for solving difficult problems and began incorporating it into their work.

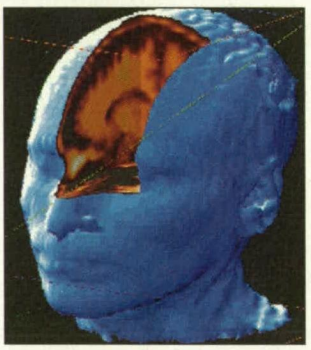
IDL's ease of use, flexible data handling, 2D and 3D modeling and display, and object-oriented programming have made it a critical element for advancing scientific knowledge and discoveries in a wide variety of disciplines. Astrophysicists use IDL for processing data from the Hubble Space Telescope. Medical researchers use it to develop new ways for interpreting a variety of medical imagery, improving non-invasive diagnostic techniques and performing microscopic analysis. Engineers rely on IDL's rapid application development and prototyping capabilities to speed product development and provide reliable, accurate data assessment "on the fly."

Research Systems is committed to technical innovation, discovery and education. Academic and research institutions benefit from Research Systems' devotion to scientific advancement. The Smithsonian Air & Space Museum, astronomers in the former Soviet Republics, the University of Colorado and the Sequoia 2000 project to explore global change are just a few of the organizations that have expanded the base of scientific knowledge with the help of Research Systems.

Research Systems' product line includes: IDL, a complete, integrated software environment for data analysis, visualization and application development; ION, IDL on the Net, which enables users of all programming levels to employ IDL's data analysis and visualization features over the Internet; ENVI® (the Environment for Visualizing Images), a remote sensing data, image processing application written in IDL that includes a suite of GIS-application features; and Research Systems' Visible Human CD™ Collection, the first complete, digital photographic reference for exploring male and female human anatomy, that includes more than 20,000 images of the human body.







IDL, the Interactive Data Language

IDL is the ideal software for data analysis, visualization, and application development. IDL's features include: advanced image processing, interactive 2D and 3D graphics, object-oriented programming, OpenGL accelerated graphics, volume visualization, integrated mathematics and statistics, flexible data I/O, a cross-platform GUI toolkit, linking to ODBC-compliant databases, and versatile program linking tools. All features are accessed via a high-level programming language.

IDL's object-oriented programming provides an extensible graphics system which speeds application development and code reuse. Built-in persistence allows you to create an object once and visualize it from various perspectives without time-consuming redraws. Because IDL's accelerated 3D graphics take advantage of OpenGL and other compatible standards, interactive, 3D graphics perform efficiently.

Professional & Technical Services

The Professional Services Group and Technical Support staff offer everything from "hands-on" training courses and on-site consulting to prompt, helpful answers via telephone and email. Research Systems also has partners throughout the world. Distributors in South America, Asia, Europe and the Pacific Rim provide an active link between Research Systems and customers outside the United States.

Research Systems
2995 Wilderness Place
Boulder, CO 80301
Tel: 303-786-9900
Fax: 303-786-9909
email: info@rsinc.com
www.rsinc.com

For More Information Circle No. 699

SL
SHERRILL·LUBINSKI

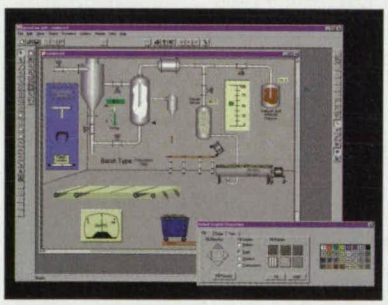
SL-GMS: The High-Performance Standard for Embedded Dynamic-Graphics Subsystems

A flexible, easy-to-use tool for developing animated displays for real-time applications.

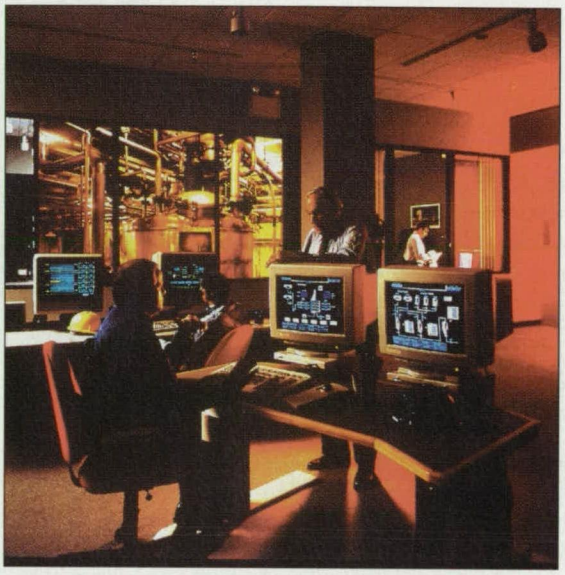
SL-GMS is a proven dynamic graphics engine, with the features needed to quickly create dynamic displays for real-time applications. Designed for easy integration into interactive environments, SL-GMS offers functionality well-suited to applications that contain a complex network active data.

Flexibility

The SL-GMS Draw component is a powerful graphical editor equipped with advanced capabilities for creating custom screen objects, as well as specifying the dynamic behaviors of those objects directly within the editor. SL-GMS greatly simplifies the building of layered applications. SL-GMS offers State Class Libraries that allow developers to easily create multi-layered sets of screens to control and animate complex application displays. Because SL-GMS encapsulates the basic elements of dynamic screens into objects, users are freed from the complex programming logic that is otherwise required to manage constantly updating layers of screens.

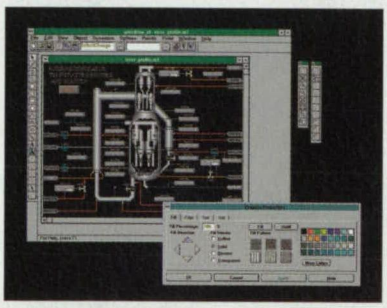


The SL-GMS real-time dynamics graphics engine embodies years of optimization in handling large data sets. This allows many different techniques for achieving maximum performance under diverse application requirements.



Portability

SL-GMS provides developers flexibility in the choice of hardware platforms. Support is provided for nearly all varieties of UNIX (X/Motif) on SUN, SGI, HP, IBM, MIPS, DEC (OpenVMS, VAX/Alpha, Digital UNIX), Windows NT (Intel, Alpha), MFC, OLE, ActiveX, SCO, QNX®.



Functionality

- Non-programmable development of complete graphical user interfaces
- Support of Motif widgets and NT control objects
- Customizable editor
- Support of imported vector and bitmap backgrounds
- Moving objects across background maps
- Dynamic vector objects (lines, circles, etc.) that change attributes to represent changing application variables
- Dynamic display of application data through plots and trends
- Cross-platform portability
- Under Windows NT, SL-GMS can be integrated as an ActiveX control component
- SL-GMS can be seamlessly integrated and displayed in a Web page via a Netscape plug-in
- Smooth pan, zoom, and decluttering

SL Corporation
Suite 110 Hunt Plaza
240 Tamal Vista Boulevard
Corte Madera, CA 94925
Tel: 415-927-1724
http://www.sl.com

©1998 Sherrill-Lubinski Corporation
All trademarks mentioned are property of their respective companies.

For More Information Circle No. 672

GaGe

Gage Applied Sciences Inc.

Manufacturer of the World's Fastest Data Acquisition and Instrumentation Products

Gage Applied Sciences was founded in 1987 by a group of Canadian engineers and entrepreneurs with a mandate of designing, manufacturing and marketing high-quality, high-speed data acquisition and instrumentation products based on the IBM PC platform.

Today, Gage is the recognized leader in the ultra-fast data acquisition market with its family of multi-MegaHertz A/D and D/A cards for the PCI and ISA Bus.

World's Fastest A/D Cards on PCI Bus

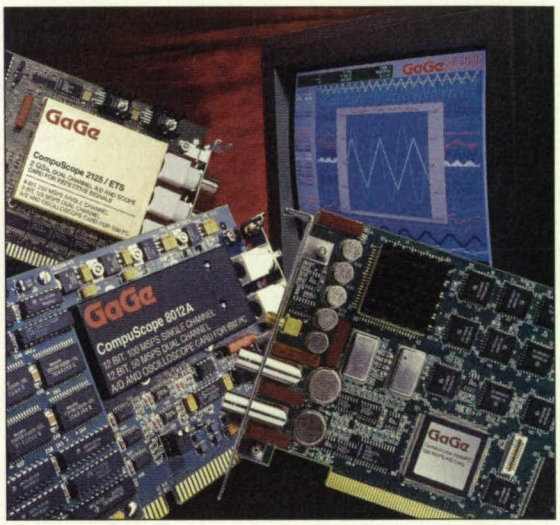
Gage manufactures the world's fastest PCI Bus A/D card, CompuScope 8500/PCI with sampling rates up to 500 MS/s and data transfer rates to PC memory of 100 MB/s!

Other products include the 100 MS/s, 12 bit A/D card, CompuScope 8012A available on both the PCI and ISA bus, the world's fastest 16 bit A/D card, CompuScope 1016, with sampling rates up to 10 MS/s, and many other models which provide excellent performance at a reasonable price.

One of the most unique features of the CompuScope product line is the very deep memory buffers it offers: up to 16 million samples. This allows the user to digitize an analog signal at very high speeds for a very long period of time.

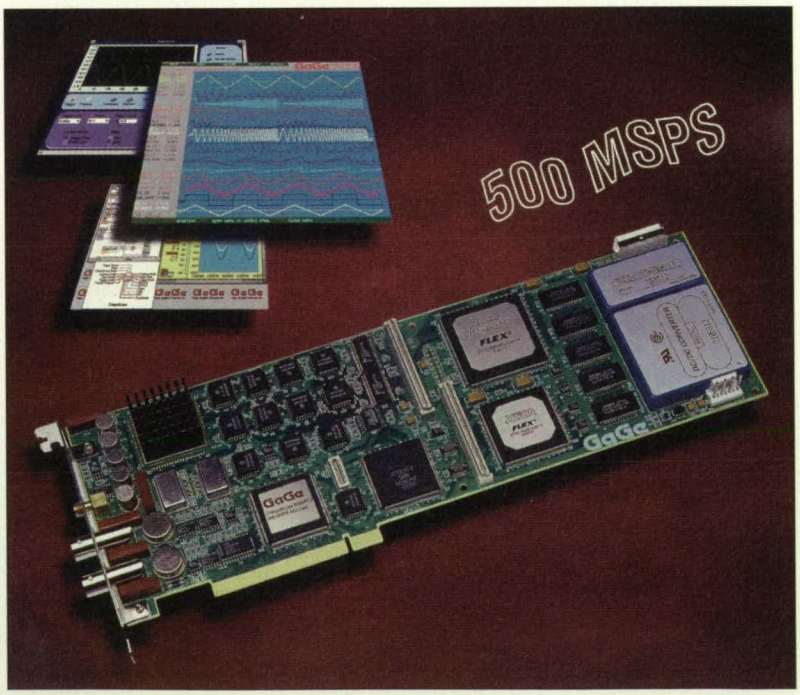
World's First Instrument Grade PC

Gage Applied Sciences offers a Revolutionary Instrument Grade PC, GagePC 580 designed for PC based Instrumentation. GagePC 580 is the only instrument grade PC available on the market with front access for all instrument connectors and a built-in color monitor. GagePC 580 houses ultra-fast PCI and ISA bus data acquisition cards providing a complete turnkey instrumentation solution.



Software Support

In addition, Gage supplies its powerful GageScope for Windows scope emulation software along with a wide variety of software drivers. Drivers are available for custom programming in DOS, QNX, Windows 95, Windows NT. Gage also supports third party packages such as MATLAB, HP VEE, LabVIEW and LabWindows CVI.



Applications

CompuScope cards have been used in many applications such as non-destructive testing, Medical Ultrasound, LIDAR, Radar, Laser Doppler Anemometry, Telephony, Communications, Disk Drive Testing, Manufacturing Test, etc.

The list keeps on expanding every day as scientists around the world find more ways of utilizing computers to solve problems by analyzing digitized data.

Gage Applied Sciences Inc.
Tel: 1-800-567-GAGE
Fax: 1-800-780-8411
e-mail: prodinfo@gage-applied.com
www.gage-applied.com

For More Information Circle No. 695

AVERY DENNISON

Worldwide Source For Bonding, Fastening and Sealing

Avery Dennison Corporation, a Fortune 200 company based in Pasadena, California, is a leader in the manufacture of pressure-sensitive adhesives and materials, office products, labels, tags, retail systems, and specialty chemicals. The Specialty Tape Division is a world-class manufacturing operation specializing in the production of pressure-sensitive adhesive tapes. The division achieved ISO 9001 certification for both its Painesville and Mentor, Ohio facilities. A sister division opened in Turnhout, Belgium in 1978 to support an expanding global market. This facility is also ISO 9001 certified.

The Specialty Tape Division provides adhesive tapes for use in automotive, appliance, electronics, business equipment, packaging, HVAC, aerospace, optical and medical applications. Offering a standard product line and customizing capabilities, the division was established in 1969. Avery Dennison offers flexible and innovative solutions with personalized and responsive customer support.

Markets Served

Industrial Converters

- Foam and Rubber Fabrications
- Nameplate & Screen-Printing Graphics
- Optical and Industrial Abrasives
- Packaging
- Plastic Molders and Extruders

OEM/OEM Converters

- Automotive & Transportation
- Aerospace
- Electronic
- Consumer
- Medical
- Appliance

Distributors/Converters

- Tape Specialists
- HVAC Distributors
- General Fabricators

Current Product Line

Proprietary coating formulations and technologies are engineered with a range of carrier feedstocks (films, foils, nonwovens, tissues, papers) into tapes that meet the fastening, bonding and sealing needs of many industries. The company produces pressure-sensitive adhesive (PSA) tapes in double-coated, single-coated, and unsupported transfer tape form and compounds its own adhesive and release coating formulations.

Avery Dennison™ brand PSA tapes offer a mix of performance characteristics on a variety of substrate surfaces, and perform under a range of environmental conditions. Using PSA tapes for fastening, joining and bonding offers benefits over conventional methods, such as easier assembly, a seamless appearance, and compliance with environmental regulations to limit airborne solvents. Besides fastening and bonding, PSA tapes can also help create a moisture barrier, shield electromagnetic waves, and reduce vibration. For medical and consumer product needs, PSAs offer properties like breathability, porosity, skin contact, or conformability to contours.

PSAs demonstrate advantages in diverse uses, such as:

- *Unsupported transfer tapes* used to laminate or bond conformable substrates, such as foams for gasketing; or to apply nameplates and decorative trims.
- *Double-linered transfer tapes* used for aircraft interior application; durable products & equipment or automotive parts.
- *Double-coated films* for appliance and automotive gasketing, foam lamination, abrasive pads and specialty packaging.
- *Double-coated tissue and nonwovens* for automotive interior trim and carpeting, bonding to foams for gasketing and sound reduction, tamper-evident closures and security tags.
- *Single-coated foams* for EKG electrodes, grounding pads, transdermal patches and IV placements.
- *Double-coated foams* for furniture, automotive and appliance trims, and molded plastic pieces and sheet goods mounting.

- *Single-coated tape* for electromagnetic and radio frequency shielding, fabrication of electronic equipment, and taping joints and seams on HVAC systems and insulation facings requiring U.L. rating.
- *Heat-activated products* for transferring pressure-sensitive adhesives to foams such as polystyrene and polyethylene.
- *Single-coated films and nonwovens* for disposable diaper tapes, wound dressings, and EKG electrodes.

Call (800) 262-2400 for information on pressure-sensitive adhesive tapes.

ISO 9001 CERTIFIED

For More Information Circle No. 669

Specialty Tape Division
250 Chester Street
Painesville, Ohio 44077
(440) 639-2600
www.averydennison.com

AVERY DENNISON

ALGOR®

Algor, Inc. produces finite element analysis and event simulation software for Windows NT/95, UNIX, and DEC Alpha running Windows NT operating systems. More than 16,000 engineers in more than 60 countries use Algor software. As a service to the mechanical engineering community, Algor presents this paper on event simulation.

Introduction

Event simulation is vastly different from what we learned in college about linear stress analysis. We were taught that stress, deformation, and displacement are functions of force. In event simulation, we assume that forces result from some type of action or motion, which produces deformation, displacement, and force.

Contrasting Event Simulation with Classical Methods

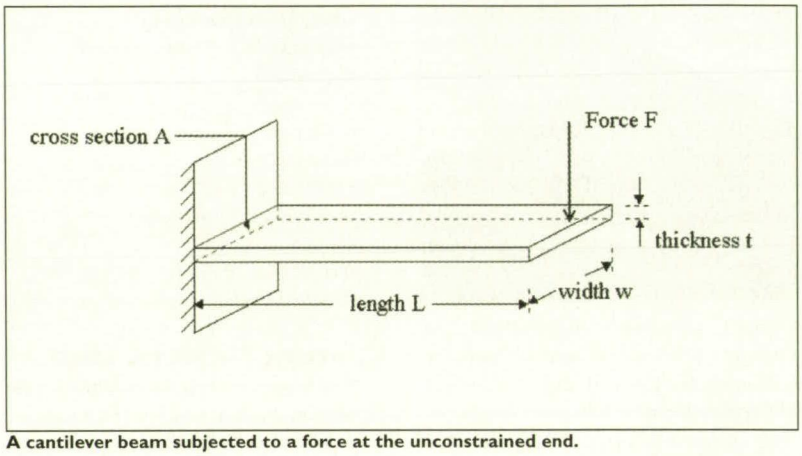
Classical Methods

As an example, let's use a cantilever beam subjected to a force at the free end, shown in the accompanying diagram. The maximum stress (at A) is given by:

$$\sigma = \frac{Mc}{I} \qquad [1]$$

M is the moment generated by the force F (M=FL), c is the distance from the neutral axis to the edge of the beam (c=t/2), and I is the area moment of inertia ($I=wt^3/12$). This result is based on Hooke's law (|F|=k|d|): force is a linear function of displacement.

In finite element analysis, the matrix equation {F} = [K] {d} is solved for the displacement vector, {d}, from the force vector {F}, and the stiffness matrix, [K]. Subsequently, the stresses are calculated from the equation {σ} =E {ε}, where {ε} is the strain vector. E is Young's modulus, which corresponds to Hooke's constant, k.



A cantilever beam subjected to a force at the unconstrained end.

All would be well if the beam were always at rest, which is the only time when equation [1] is valid. However, the engineer must consider the "worst case scenario," which occurs when the beam is in motion.

Event Simulation

According to Newton's second law,

$$F = ma \qquad [2]$$

or force equals mass multiplied by acceleration. This law quantifies that mass causes resistance to changes in motion. Note that under the influence of gravity, a body at rest generates a force (mg), where g is the acceleration due to gravity.

In special cases of constant acceleration (i.e., gravity field near earth's surface) and short-lived events (say of length Δt), Equation [2] can be rewritten as

$$F = m\frac{\Delta v}{\Delta t} \text{ or } F\Delta t = m\Delta v \qquad [3]$$

where Δv is the amount by which the velocity changes during Δt time. Thus a force of 1,000,000 lbs. acting over 0.000001 seconds produces the same impulse (or change in momentum) as a force of 1 lb. over 1 second.

Event simulation relies on the combination of Newton's second law and Hooke's law as follows:

$$F = ma = -kd \quad \text{or} \quad ma + kd = 0 \qquad [4]$$

The force is in the opposite direction of the displacement, requiring a negative sign in front of k. Also, note that the nebulous quantity force can be eliminated, and that the concept of time has been introduced through the acceleration. To simulate real world problems, we can also take damping or friction into account by:

$$F = -cv \qquad [5]$$

where v is the velocity and c is a constant. Combining equations [4] and [5] and eliminating force (F), we obtain:

$$ma + cv + kd = 0 \qquad [6]$$

or in matrix form:

$$[M]\{a\} + [C]\{v\} + [K]\{d\} = 0 \qquad [7]$$

This is the basic equation of event simulation; note how it models the combination of motion, damping, and mechanical deformation. If stresses are of interest, they can be calculated during the analysis by applying the formula {σ} = E{ε}, where {ε} (the strain vector) is easily obtained from the displacement vector {d}. In event simulation, the concept of force is superfluous.

Numerical Example

Imagine a cube of mass m impacting a rigid surface along a face. We are interested in the maximum deformation experienced by the cube. We first perform a hand calculation for the maximum compression length. Then we use event simulation to solve the same problem more quickly and compare results.

By Newton's second law, the impact force is given by equation [3]. We assume that the cube's entire mass is located at its centroid and that for any particular location on the cube, the acceleration is constant throughout the impact. Equation [3] takes the form:

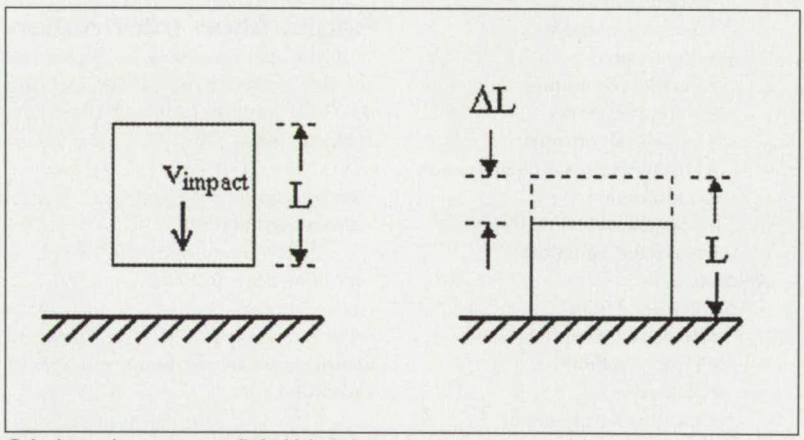
$$F = \frac{1}{2} m \frac{\Delta v}{\Delta t} \qquad [8]$$

where Δv is the change in velocity of the top of the cube during the impact interval, Δt. the factor of 1/2 in equation [8] is needed because we are applying equation [3] at the centroid. We expect the top of the cube to move twice as fast as its centroid once contact is made. The constant acceleration assumption combined with basic kinematics allows us to obtain an expression for the amount by which the cube deforms during impact:

$$\Delta L = \frac{at^2}{2} \quad \text{or} \quad \Delta L = -\frac{\Delta v \Delta t}{2} \qquad [9]$$

$$\text{or} \quad \Delta L = -\frac{v_{impact}\Delta t}{2},$$

where v_{impact} is the velocity of the top face of the cube, at the moment that contact is made. We need the negative sign in equation [9] because Δv is negative and we seek a positive value for ΔL. Note how Δv is replaced by just v_{impact} because at the time of greatest deformation, the top of the cube is not moving.



Cube just prior to contact (left side). Cube at time of maximum deformation (right side).

By Hooke's law, the force on the cube is given by

$$F = -k\Delta L \qquad [10]$$

Combining equations [8] through [10], yields:

$$\Delta L = \frac{v_{impact}}{2}\sqrt{\frac{m}{k}}. \qquad [11]$$

Putting k in terms of E (k=EL for a cube length L deforming along an axis perpendicular to a face), one obtains:

$$\Delta L = \frac{v_{impact}}{2}\sqrt{\frac{m}{EL}}. \qquad [12]$$

Using Algor software, we simulate the same impact problem using these values: cube length (L) = 1.0 in., mass (m) = 0.000253 lb_m, material Young's modulus (E) = 10^7 lb/in.^{2}, starting elevation = 100 in., and gravity field = 386.4 in/sec^2. The software predicts a maximum deformation (ΔL) of 0.000694 in. which compares closely with the value of 0.000699 in. given by equation [12]. Note that we did not need the impact force or velocity.

Conclusions

This example demonstrates the difficulty of analyzing a simple impact problem without using Algor's event simulation software. Imagine how involved, or even impossible, the hand calculation for force would be for a typical part — not a cube. And, without the force, a static finite element analysis would have little meaning. On the other hand, event simulation software can handle a model of any complexity. Furthermore, event simulation has the useful by-product of generating a "frame-by-frame" record of the event.

Algor, Inc.
150 Beta Drive
Pittsburgh, PA 15238-2932
Tel: 412-967-2700
Fax: 412-967-2781
e-mail: info@algor.com
http://www.algor.com

For More Information Circle No. 682

OptiCON '98 In Focus Optimization in Focus Optimization

Bringing Optimization Technology Into Focus

OptiCON '98, the first annual optimization conference, will be held in Newport Beach, California from October 8-9. The purpose of the conference is to bring together users, researchers, developers, and software vendors to present and discuss current developments in software, concepts, theoretical and numerical methods, applications, and problems in applying optimization to the design of complex engineering systems. The conference is presided over by an impartial technical panel knowledgeable in many areas of optimization technology. OptiCON '98 is hosted by Altair Computing, Inc., in conjunction with Hewlett Packard, to bring you the latest advancements in the field of optimization in an interactive and educational environment.

Dr. Harold Thomas, chairman of the conference says, "It is our hope that OptiCON will bring together a lively exchange of optimization information, to help us focus on the future development of optimization, and to determine where this technology is heading. It is critical that forums like OptiCON exist so that optimization professionals can mutually benefit from sharing their knowledge about this exciting and evolving technology."

Call for Papers

Today's optimization applications encompass aerospace, automotive, heavy machinery, manufacturing, naval, offshore, and civil structures, each having their own unique requirements in analysis and optimization. The rapid development of information systems and technology, including the advancements in computing environments, have radically altered the application of optimization in engineering systems. The conference intends to bring all these aspects together, offering an advanced technical forum in which to exchange concepts, ideas, and methods with industry experts, academic researchers, and software suppliers.

Papers on the latest developments and applications of optimization in the design of engineering systems are solicited. The scope of the conference includes current applications, multidisciplinary optimization, emerging research topics, and advances in information systems and technology that enhance the application of optimization and computing systems used in any optimization management system.

Topics

Topics of interest include:

- Software and computing systems in optimization

Emerging methods in:

- Numerical analysis
- Sensitivity analysis
- Algorithms
- Parallel computing
- Neural networks
- Genetic algorithms
- Multidisciplinary analysis and optimization
- Approximation methods
- Separable functions

Applications in:

- Vehicle design
- Manufacturing processes
- Heavy machinery
- Military
- Product development
- Materials
- Civil
- Architectural

Management of optimization processes:

- Software integration
- Interactive graphical processing
- Information systems and technology
- Emerging trends

Abstract Submission

Please submit completed abstracts in one of the following methods. The abstract should be a minimum of 500 words.

Electronically:

If you have Internet access, go directly to the following web location: http://www.altair.com, and click on the Special Events button. Follow the directions on your screen to complete the abstract submittal form. Please fill in all details requested on the form.

Mail:

Please contact us on the OptiCON '98 information line at (248) 614-2400, ext. 300, or send us an e-mail at opticon@altair.com to request a complete package of information for mail submissions.

Important Dates

Abstract Deadline	May 15
Camera-ready Papers Due	August 15
Conference Day 1	October 8
Conference Day 2	October 9

Registration Information

If you are interested in registering for this conference, please call the OptiCON conference line at (248) 614-2400, ext. 300.

Registration fee: $750.00
Pre-registration fee
(before August 15): $500.00
Presenter fee: $250.00

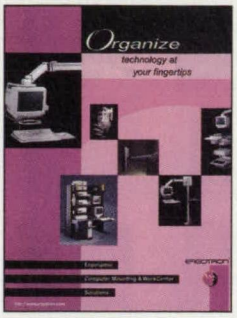
For companies with five or more attendees, please ask about our special discounted rates.

Need More Information?

Send us e-mail at opticon@altair.com, or contact the Altair website at http://www.altair.com, or the Hewlett Packard website at http://www.hp.com.

OptiCON '98
Altair Computing, Inc.
1757 Maplelawn
Troy, MI 48084-4004
Tel: 248-614-2400
Fax: 248-614-2411
e-mail: opticon@altair.com
http://www.altair.com

For More Information Circle No. 674



Flat Panel Display/ Computer Mounting Solutions

Ergotron's family of Computer WorkCenters and Flat Panel Mounting Solutions bring computer access to the "point of need." Utilizing a patented Suspension Technology, Ergotron products offer a unique combination of ergonomic adjustability; rugged construction; modular, space-saving design; and computer accessibility. Carts, wall-mounts, pole-mounts, and free-standing WorkCenters are available in multiple designs.

Ergotron, Inc., 1181 Trapp Road, St. Paul, MN 55121; Tel: 612-681-7600; Fax: 612-681-7715; http://www.ergotron.com

Booth 3813

For More Information Circle No. 679

Full New Line of Time Delay Relays

SAIA-Burgess Electronics' new catalogs 06/303 and 06/304 illustrate the wide range of multi-voltage timers available in mono- or multi-function, SPST, SPDT, DPDT, either in 22.5 mm, 17.5 mm DIN rail mountable, or 48 x 48 mm housing. All timers are UL, C-UL approved and meet CE standards. Factories are ISO 9001 approved. All timers are backed by an industry-exceptional 3-year limited warranty to underline the high quality and good reputation.

SAIA-Burgess Electronics Inc.; Tel: 800-429-0365; e-mail: sales@saia-burgess-usa.com; www.saia-burgess-usa.com

Booth 7400

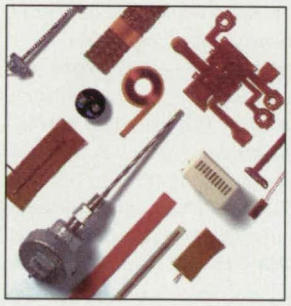
For More Information Circle No. 683

Nook Industries is a major source of linear motion products. Linear motion & power transmission devices include PowerTrac™ rolled, precision rolled, and precision ground ball screws, matching ball nuts, Bridgeport conversion kits, and ball splines; PowerAc™ precision acme screws, nuts, and mounting flanges; New PowerAcPlus™ adjustable pre-loaded plastic nuts; ActionJac™ worm gear screw jacs and electric cylinders for efficient lifting and precise positioning; PowerTrax™ precision linear ball bearings with closed, open, and stainless steel outer shells, precision shafting, shaft supports, pillow blocks, rail assemblies, powered precision slides; metric and trapezoidal lead screws; and accessories.

Nook Industries, Inc., 4950 E. 49th St., Cleveland, OH 44125; Tel: 216-271-7900; Fax: 216-271-7020; e-mail: nook@nookind.com; www.nookind.com

Booth 205

For More Information Circle No. 675



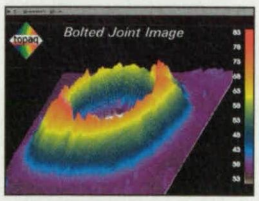
Heaters, Temperature Sensors, Flex-Circuits

Ensure precise thermal control with heating elements, temperature sensors, and controllers from Minco. The company manufactures stock and custom RTD sensors and flexible Thermofoil™ heaters for medical, aerospace, and commercial applications. Also available are flex-circuits, single-layer through rigid-flex.

Minco Products, Inc., 7300 Commerce Lane, Minneapolis, MN 55432; Tel: 612-571-3121; Fax: 612-571-0927; e-mail: sales@minco.com; www.minco.com

Booth 7261

For More Information Circle No. 691



New Tactile Pressure Sensor

The Topaq Advanced Imaging System provides a thorough analysis of tactile pressure distribution and magnitude between any two contacting or impacting surfaces. The Windows-based sensor system uses a unique tactile pressure recorder and renders high-definition color maps revealing precisely how force is disbursed in your application. Capabilities include the ability to determine average pressure and total force over a user-defined area, 3D topography, enlargements and reductions, and sophisticated image filtering and enhancement.

Sensor Products Inc., USA, 24 Castle Ridge Park, East Hanover, NJ 07936-3547; Tel: 800-755-2201 or 973-884-1755; Fax: 973-884-1699; e-mail: sales@sensorprod.com; www.sensorprod.com

Booth 8363

For More Information Circle No. 694

Metal Belts & Drive Tapes

A product brochure is available describing the various attributes that make metal belts and drive tapes an exceptional and exciting option for design engineers. Manufactured by Belt Technologies for 25 years, this unique family of products has helped design engineers overcome challenging application requirements in the electronics, aerospace, biomedical, optical, and packaging industries.

Belt Technologies, Inc., PO Box 468, Agawam, MA 01001; Tel: 413-786-9922; Fax: 413-789-2786.

Booth 8170

For More Information Circle No. 678

TEKNOR
INDUSTRIAL COMPUTERS INC.

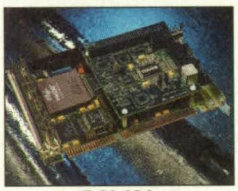
Teknor Industrial Computers Inc.

Industrial Computers for Hi-Tech Applications

Teknor is regarded as the most technologically advanced and reliable company in the design and development of industrial single-board computers and systems in the world. In fact, Teknor is the largest manufacturer of highly integrated, high-performance industrial computers aimed at major OEMs and system integrators in the industrial equipment, telecommunication systems, and medical devices markets. With headquarters in Montreal, Canada, and in Florida, and with regional offices in Germany and the USA, Teknor has technical sales representatives and distributors across the glove. Teknor's success stems from unmatched technical support and dedicated customer service, together with superior engineering and excellence in manufacturing at its state-of-the-art ISO-9001-certified facility.

Current Products

Compact PCI Boards & Systems — Compact PCI is going to explode the standard platform in the telecom megamarket and Teknor is there to conquer it. Teknor's Compact PCI computers combine the versatility and reliability of the Eurocard form factor. This unique architecture has built-in power to process real-time data, maintain high availability in mission critical applications, and best of all, it's very affordable.



PCI-936

Pentium® Processor with MMX™ Technology PCI-ISA Bus Industrial Single-Board Computers — The most recent addition to the industrial SBC line is the Pentium-based PCI series. The PCI single-board computer and passive backplane series offer the telecom and medical systems companies the high throughput offered by PCI bus technology at prices competitive with off-the-shelf PC products.

Half-Size 386 to Pentium® Processor with MMX™ Technology ISA Bus Industrial Single-Board Computers — The VIPer SBC series takes integration one step further by adding PC/104 expansion ability, SCSI, Enhanced IDE, Flash & Ethernet options, and local bus SVGA video with simultaneous flat panel and CRT operations. The VIPer series is ideal for embedded or small passive backplane applications that require full PC functionality in a compact package. Typical applications include mobile data acquisition systems and in-vehicle GPS systems.

High-Integration Real-Time Video Interface Module — The VIPer Vision TEK-380 adds real-time imaging functionality to Teknor's industry-leading VIPer single-board computers. It produces high-quality video for LCDs and analog CRT screens while occupying no bandwidth at the system bus level.

Teknor Industrial Computers Inc., 7900 Glades Road, Boca Raton, FL 33434; Tel: 561-883-6690 or 800-3874222; Fax: 561-883-6690; www.teknor.com

For More Information Circle No. 677

Rapid Product Development Services

ARRK Creative Network Corporation will take your new product from design to creation. As the most experienced professionals in the industry, ARRK provides the best technical expertise available, responding quickly and decisively to your production needs, whether you need one simple prototype or a complicated series of products. ARRK's capabilities include rapid prototyping, CAD/CAM machining, fabricated prototypes, vacupressure molding, aluminum castings, pre-production injection molding, and model making.

ARRK Creative Network Corporation, 8880 Rehco Road, Bldg. A, San Diego, CA 92121; Tel: 619-552-1587; Fax: 619-552-8231; e-mail: info@arrk.com; http://www.arrk.com

Booth 4580

For More Information Circle No. 685

Cardinal Aluminum Offers More New Services

Cardinal Aluminum — a leading-edge manufacturer, fabricator, and finisher of custom aluminum extrusions — adds more new services for its customers.

- Four more CNC Machining Centers, two having the unique capability of combining 5-axis CNC machining and sawing operations on extrusions up to 22 feet in length!
- CNC Roll Bender for single or multiple bends, incorporating up to 12 different radii in a single bend routine.
- Certification to provide architectural powder coating that meets AAMA spec 605.2 — and Cardinal's powder coating operation can take extrusions up to 25 feet long!

Cardinal Aluminum Co., 6910 Preston Highway, Louisville, KY 40259-0987; Tel: 800-EXTRUDE (800-398-7833) or 502-969-9302; Fax: 502-968-4269; www: 1800extrude.com

Booth 7065

For More Information Circle No. 688

RGB Spectrum develops and manufactures products which integrate computer and video signals for display and communications. Products include the RGB/Videolink® video scan converters, the ComputerWall® multi-screen processor, the RGB/View® and SuperView™ lines of real-time video windowing systems, the SynchroMaster® computer signal synchronizers, and other specialized scan converters and processors. External peripherals and VME boards. Applications include command-and-control, simulation and training, remote surveillance, video conferencing, large-screen communications, and virtual reality.

RGB Spectrum, 950 Marina Village Pkwy., Alameda, CA 94501; Tel: 510-814-7000; Fax: 510-814-7026; e-mail: sales@rgb.com; http://www.rgb.com

For More Information Circle No. 676

Vol. 22, No. 3 March 1998 This card expires: August 31, 1998

Fast Fax Information Form

Use this form for quickest processing of your inquiry, or if the bind-in card has been removed. Fax: (413) 637-4343.

Name _____

Company _____

Address _____

City/St/Zip _____

Phone _____ Fax _____

e-mail _____

Circle the numbers below to order Technical Support Packages for briefs in this issue.

101	102	103	104	105	106	107	108	109	110	111	112	113	114
115	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142
143	144	145	146	147	148	149	150	151	152	153	154	155	156
157	158	159	160	161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180	181	182	183	184
185	186	187	188	189	190	191	192	193	194	195	196	197	198
199	200	201	202	203	204	205	206	207	208	209	210	211	212
213	214	215	216	217	218	219	220	221	222	223	224	225	226
227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254
255	256	257	258	259	260	261	262	263	264	265	266	267	268
269	270	271	272	273	274	275	276	277	278	279	280	281	282
283	284	285	286	287	288	289	290	291	292	293	294	295	296
297	298	299	300	301	302	303	304	305	306	307	308	309	310

There is a $5.00 postage & handling charge for each TSP ordered, payable by check or credit card.

Method Of Payment:

❒ Check to *NASA Tech Briefs*

❒ American Express ❒ VISA ❒ Mastercard

Card No. _____

Exp. Date _____

Signature _____

No. of TSPs: _____ x $5.00 each = total enclosed: $_____

Circle the numbers below to receive more information about products and services featured in this issue.

401	402	403	404	405	406	407	408	409	410	411	412	413	414
415	416	417	418	419	420	421	422	423	424	425	426	427	428
429	430	431	432	433	434	435	436	437	438	439	440	441	442
443	444	445	446	447	448	449	450	451	452	453	454	455	456
457	458	459	460	461	462	463	464	465	466	467	468	469	470
471	472	473	474	475	476	477	478	479	480	481	482	483	484
485	486	487	488	489	490	491	492	493	494	495	496	497	498
499	500	501	502	503	504	505	506	507	508	509	510	511	512
513	514	515	516	517	518	519	520	521	522	523	524	525	526
527	528	529	530	531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550	551	552	553	554
555	556	557	558	559	560	561	562	563	564	565	566	567	568
569	570	571	572	573	574	575	576	577	578	579	580	581	582
583	584	585	586	587	588	589	590	591	592	593	594	595	596
597	598	599	600	601	602	603	604	605	606	607	608	609	610
611	612	613	614	615	616	617	618	619	620	621	622	623	624
625	626	627	628	629	630	631	632	633	634	635	636	637	638
639	640	641	642	643	644	645	646	647	648	649	650	651	652
653	654	655	656	657	658	659	660	661	662	663	664	665	666
667	668	669	670	671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690	691	692	693	694
695	696	697	698	699	700	701	702	703	704	705	706	707	708
709	710	711	712	713	714	715	716	717	718	719	720	721	722
723	724	725	726	727	728	729	730	731	732	733	734	735	736
737	738	739	740	741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760	761	762	763	764
765	766	767	768	769	770	771	772	773	774	775	776	777	778
779	780	781	782	783	784	785	786	787	788	789	790	791	792
793	794	795	796	797	798	799	800	801	802	803	804	805	806
807	808	809	810	811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830	831	832	833	834

Mail in envelope to:
NASA Tech Briefs
PO Box 5077
Pittsfield, MA 01203-5077
or fax to: (413) 637-4343
Thank you for your order.

TSPs can be accessed free on-line at www.nasatech.com

Training of Neural Networks by Modified Taguchi Techniques

Neural networks learn faster than they do with gradient-descent techniques or genetic algorithms.

NASA's Jet Propulsion Laboratory, Pasadena, California

Modified Taguchi techniques of robust design optimization are used in an innovative method of training artificial neural networks — for example the network shown in the figure. As in other neural-network-training methods, the synaptic weights (strengths of connections between neurons) are adjusted iteratively in an effort to reduce a cost function, which is usually the sum of squared errors between the actual network outputs and the prescribed (correct) network outputs for training sets of inputs. However, this method offers advantages over older methods, as explained below.

Heretofore, the most popular neural-network-training methods have been based, variously, on gradient-descent (GD) techniques or genetic algorithms (GAs). GD techniques are local search/optimization techniques; in a typical case, a GD technique leads to a local minimum of the cost function, which may not be the desired global minimum. Moreover, GD learning is slow, typically requiring thousands of iterations. GA learning involves global searches but is also slow, typically requiring hundreds of generations with hundreds of individuals in the population. The present innovative method involves global searches and enables a neural network to learn much faster (equivalently, in fewer iterations) than do GD- and GA-based methods.

In the present method, each of the N synaptic weights is treated as one of N design parameters to be optimized by Taguchi techniques. At each iteration, a number, M, of trial network designs are considered. In each design, each parameter is set at one of three distinct arbitrary levels. The various designs considered at each iteration are thus represented by M sets of N parameters each, each set being a distinct combination of the three levels. The ensemble of all M trial designs considered at each iteration can thus be represented by an $N \times M$ rectangular array. For example, the table shows an array of $M = 27$ trial sets of $N = 13$ parameters each for the neural network illustrated in the figure.

The cost is computed for each trial design. For each parameter, one computes three different cumulative costs, each comprising the sum of all costs for one of the three parameter levels. The three cumulative costs are compared. Then the search range for the parameter is narrowed and is shifted toward whichever level gave the lowest cumulative cost; that is, three shifted, more-closely-spaced levels of the parameter are chosen for the trial designs on the next iteration.

The process is repeated until the parameters converge on values that make

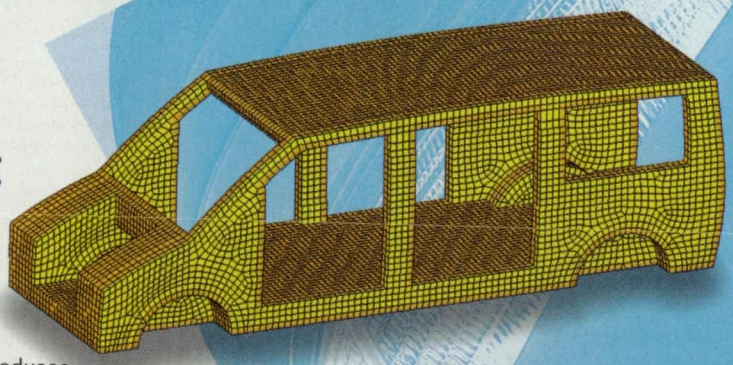
	Inputs			Output
	X_1	X_2	X_3	O
	0	0	0	0.2870
	0	0	1	0.3375
	0	1	0	0.3766
	1	0	0	0.2654
	1	0	1	0.3139
	1	1	0	0.3044
	1	1	1	0.3553

Trial Design	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}	W_{12}	W_{13}	Cost
1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0.19
2	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	0.26
3	-1	-1	-1	-1	1	1	1	1	1	1	1	1	1	2.97
4	-1	0	0	0	-1	-1	-1	0	0	0	1	1	1	2.18
5	-1	0	0	0	0	0	0	1	1	1	-1	-1	-1	0.28
6	-1	0	0	0	1	1	1	-1	-1	-1	0	0	0	0.07
7	-1	1	1	1	-1	-1	-1	1	1	1	0	0	0	0.84
8	-1	1	1	1	0	0	0	-1	-1	-1	1	1	1	1.75
9	-1	1	1	1	1	1	1	0	0	0	-1	-1	-1	0.45
10	0	-1	0	1	-1	0	1	-1	0	1	-1	0	1	1.20
11	0	-1	0	1	0	1	-1	0	1	-1	0	1	-1	0.00
12	0	-1	0	1	1	-1	0	1	-1	0	1	-1	0	0.35
13	0	0	1	-1	-1	0	1	0	1	-1	1	-1	0	0.07
14	0	0	1	-1	0	1	-1	1	-1	0	-1	0	1	0.76
15	0	0	1	-1	1	-1	0	-1	0	1	0	1	-1	0.27
16	0	1	-1	0	-1	0	1	1	-1	0	0	1	-1	0.08
17	0	1	-1	0	0	1	-1	-1	0	1	1	-1	0	1.12
18	0	1	-1	0	1	-1	0	0	1	-1	-1	0	1	0.10
19	0	-1	1	0	-1	1	0	-1	1	0	-1	1	0	0.26
20	1	-1	1	0	0	-1	1	0	-1	1	0	-1	1	1.47
21	1	-1	1	0	1	0	-1	1	0	-1	1	0	-1	0.04
22	1	0	-1	1	-1	1	0	0	-1	1	1	0	-1	0.39
23	1	0	-1	1	0	-1	1	1	0	-1	-1	1	0	0.10
24	1	0	-1	1	1	0	-1	-1	1	0	0	-1	1	0.87
25	1	1	0	-1	-1	1	0	1	0	-1	0	-1	1	0.12
26	1	1	0	-1	0	-1	1	-1	1	0	1	0	-1	0.02
27	1	1	0	-1	1	0	–1	0	–1	1	–1	1	0	0.75

An **Array of Parameters** comprising 27 sets of synaptic weights represents the trial designs of the network on the first iteration. The costs for the sets of training inputs and outputs are then analyzed according to the procedure described in the text to shift and narrow the search ranges of the parameters on the next iteration.

Form Following Function...

The best designs...



Altair® OptiStruct®

Optimize Your Concept Design Possibilities

Altair® OptiStruct® is the award-winning, finite element-based optimization tool that produces the most effective design concepts using topology optimization. OptiStruct quickly creates conceptual designs needing only minimum information. When applied at the beginning of the design process, OptiStruct allows you to easily reduce design cycle time and decrease your development costs and time to market.

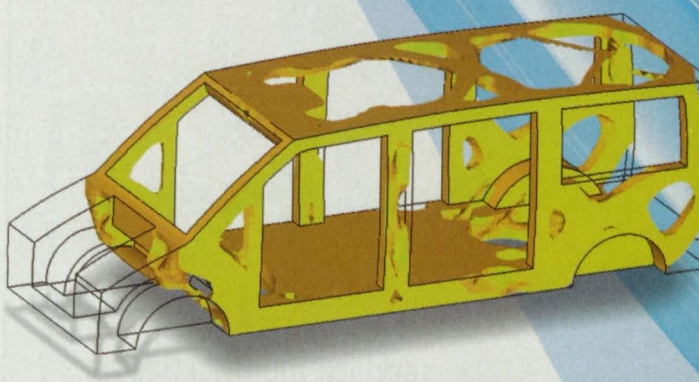
Given only a finite element model's package space, with loads and boundary conditions applied, OptiStruct suggests a concept design layout optimized for maximum stiffness and natural frequency. OptiStruct improves your design process by optimizing designs when the greatest improvements are possible.

OptiStruct works in conjunction with other Altair software, including Altair HyperMesh®, an advanced finite element pre- and post-processor, to provide the best value and highest performance for your optimization needs.
All Altair software products run on Hewlett Packard's PA-RISC® family of workstations and are tuned to take full advantage of HP's latest VISUALIZE graphics architecture.

When structural performance is a concern, you can rely on Hewlett Packard workstations and Altair OptiStruct to deliver the best designs right from the start.

Visit our website or call to discover why companies are switching to Altair and Hewlett Packard computer systems.

Right from the start



HEWLETT® PACKARD
Premier Solution Partner

ALTAIR COMPUTING

Altair Computing, Inc.
1757 Maplelawn
Troy, MI 48084-4004
Tel. 248.614.2400
Fax. 248.614.2411
E-mail: info@altair.com
Web: http://www.altair.com

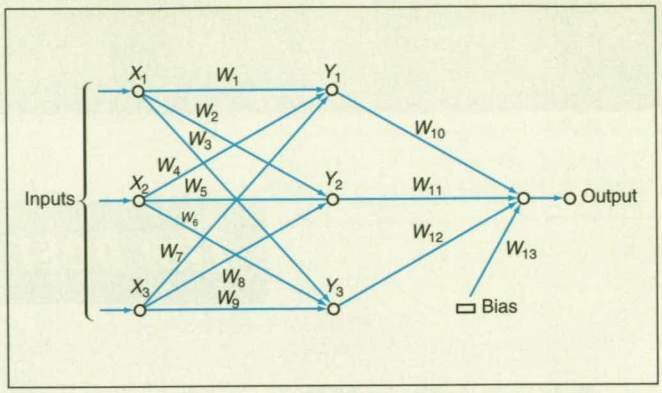
Altair OptiStruct and Altair HyperMesh are trademarks of Altair Computing, Inc.
PA-RISC is a trademark of Hewlett Packard.

ZIPPERTUBING...
Zip it on for CE Mark solutions

Zippertubing's Instant "Zip On® Shielding" is the fast, economical way to shield wire and cable. Re-enterable, it allows designers to evaluate electrical performance without system redesign. Zippertubing® shields include foils, meshes, magnetic and conductive cloths. Jackets to protect against chemical, mechanical, electrical and thermal environments are available in flat, round and custom shapes and sizes. For details contact:

ZT® **THE ZIPPERTUBING® CO.**
P.O. Box 61129, Los Angeles, CA 90061
(800) 321-8178 • FAX (310) 767-1714
www.zippertubing.com

For More Information Circle No. 438

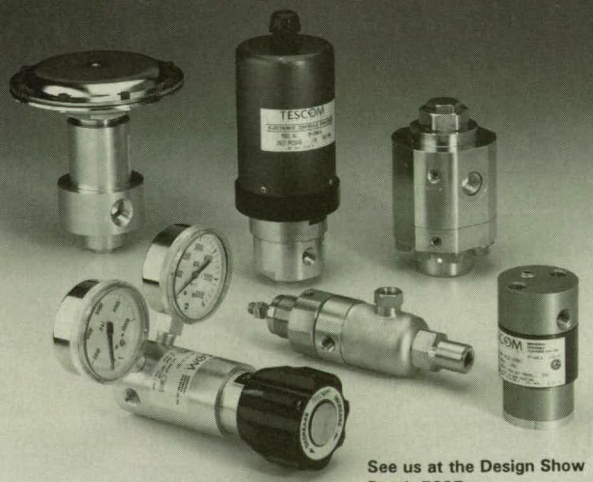


This **Representative Neural Network** contains seven neurons connected via 13 synaptic weights W_i. The output of one typical node is given $Y_1 = f(W_1X_1+W_4X_2+W_7X_3)$, where $f(x)$ is a sigmoidal nonlinear function that could be, for example, $(1+e^{-x})^{-1}$.

the cost acceptably small. Typically, the search range for each parameter can be narrowed by half on each iteration, so that the intervals containing the solution can shrink by a factor of about 10^3 in only ten iterations. Thus, learning time is shortened considerably, relative to GD- and GA-based methods.

This work was done by Julian O. Blosiu and Adrian Stoica of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 115*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-20018

Pressure Control Solutions



See us at the Design Show Booth 7237

5000+ standard modifications!

- Largest selection of pressure regulators in the industry.
- Pressure ranges from vacuum to 20,000 PSIG. • Hydraulic, pneumatic & corrosive service. • Choice of porting options, loading styles, flow capacities & materials of construction.
- Electronic/computer operated controllers for regulators.

An ISO 9001 Quality System Certified Company

TESCOM CORPORATION
Call: 1-800-447-9643

For More Information Circle No. 439

Expressing Object-Oriented Concepts in Fortran 90

Object-oriented techniques could prove advantageous in writing complex Fortran-based scientific programs.

NASA's Jet Propulsion Laboratory, Pasadena, California

A methodology for object-oriented programming in Fortran 90 has been developed. The methodology provides for emulation of the most important object-oriented concepts of C++; namely, classes (including abstract data types, encapsulation, and function overloading), inheritance, and dynamic dispatching. Previously, object-oriented programming in Fortran 90 was not considered possible.

This methodology makes the capabilities afforded by object-oriented techniques available to developers of complex Fortran-based scientific programs; thus, it becomes possible to combine some of the power and flexibility of C++ with the maturity and established scientific-computing capability of Fortran. An important advantage of this methodology is that Fortran programmers need not learn a new, complex language — viz. C++.

The most fundamental concept in C++ that must be implemented in Fortran 90 is the concept of classes. Each class contains a distinct data type and the procedures that can be performed by the class. The elements (or components) of the data type are the class data members, and the procedures are the class member functions (or methods). In Fortran 90, one defines a class as a module that contains exactly one abstract data type (called a "derived type") and the proce-

dures that work exclusively on that type. A module in Fortran can also contain data that correspond to static class members in C++.

Another C++ concept that is essential to object-orientation and that must be implemented by hand in Fortran 90 is that of inheritance. Inheritance makes it possible to create a hierarchy of classes in which a base class contains the common properties of the hierarchy and derived classes can modify and specialize these properties. A derived class contains all the class data members of the base class and can add new class data members. Further, a derived class contains all the class member functions of the base class and can modify these functions or add new ones.

A third important C++ concept that must be implemented manually in Fortran 90 is that of dynamic dispatching or run-time polymorphism. By virtue of inheritance, a single method name can be made to respond differently to different objects in an inheritance hierarchy. Dynamic dispatching enables a single object name to refer to any member of an inheritance hierarchy and enables a procedure to resolve, at run time, which object is the referent. This ability is useful because it enables one to write a generic program for a whole class of related objects, yet make the program behave differently, depending on which object is in use.

To implement dynamic dispatching in Fortran 90, it is necessary to construct two features: (1) a pointer object that can point to any member in an inheritance hierarchy and (2) a dispatch mechanism (or method lookup) that can select, on the basis of the class referred to in the pointer object, the appropriate procedure (or method) to execute. In C++, these features are incorporated automatically by use of virtual functions. In Fortran 90, they are constructed by implementing a subtype class. Although the details of dynamic dispatching are thereby exposed to the programmer, they can be hidden from the procedures that make use of the subtype class, as in C++.

Multiple inheritance in C++ enables one to create composite classes that have the properties of their bases classes. In Fortran 90, one can implement a composite class by including the base classes as components in a module, along with the USE operator to bring the base classes into scope.

Unlike in C++, templates and parameterized types are not supported in Fortran 90, and no effective way to emulate them has been found. A Fortran 90 programmer must explicitly provide some features that are automatically available in C++. Fortran 90 allows only a limited number of operators to be overloaded.

In efforts to write object-oriented plasma-simulation computer codes in both Fortran 90 and C++, each of these languages was found to offer both advantages and disadvantages, some in addition to those mentioned above. In the C++ version of the code, it was necessary to create special classes to utilize self-describing multidimensional arrays, which were automatically available in Fortran 90. On the other hand, it was necessary to create special subtype classes in Fortran 90 to emulate the dynamic dispatching that was automatically available in C++. Because type checking in Fortran 90 was stricter than in C++, more errors were caught by the compiler and debugging proceeded more quickly. It was necessary to write more code in Fortran 90. The execution time for the Fortran 90 version was about half that of the C++ version.

This work was done by Viktor K. Decyk and Charles D. Norton of Caltech and Boleslaw K. Szymanski of RPI for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 112*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). NPO-20180*

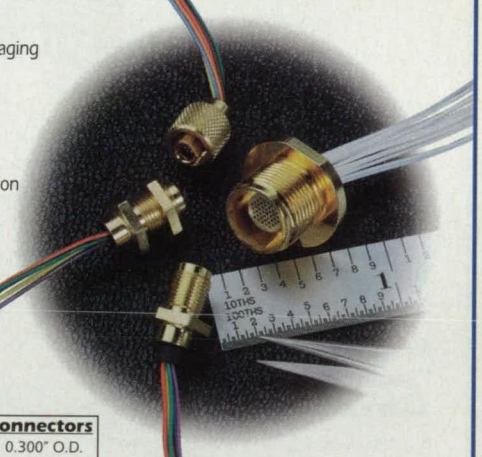
Leading the Way in Nanominiature Connector Technology.

All Nanonics Nanominiature Connectors and Harness Assemblies Feature:

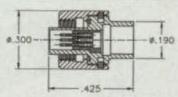
- High Density Packaging Solutions
- Minimum Weight and Mass
- Durable and Rugged Construction
- Outstanding Electrical Performance

.025" Pitch Circular Connectors

MIL/Aero Performance



In Line Metal Connectors
7 Position – Approx. 0.300" O.D.
19 Position – Approx. 0.400" O.D.
44 Position – Approx. 0.520" O.D.



7 Position Plug Assembly

For further information, technical applications or catalog requests:
1-800-242-NANO (6266)
www.nanonics.com/catalog/

NANONICS® CORPORATION

Nanonics Corporation ▪ 21644 North 14th Avenue ▪ Phoenix, Arizona 85027
Phone: (602) 581-6188 ▪ Fax: (602) 581-8242

For More Information Circle No. 440

We Do TFT Monitors

Flat panel displays. Operator interface workstations.
For Automation, Process Control or the Factory Floor.
No matter what your application or budget, MiTAC can deliver a low-cost, quality solution.

- **NEMA 4/12 10.4" TFT display with touchscreen**
- **1-slot ISA, 6-slot ISA or 6-slot PICMG passive backplane chassis**
- **10.4" or 12.1" TFT flat panel monitors**
- **300 nits, 40,000 plus hours MTBF**

One of the world's largest manufacturers of PCs.

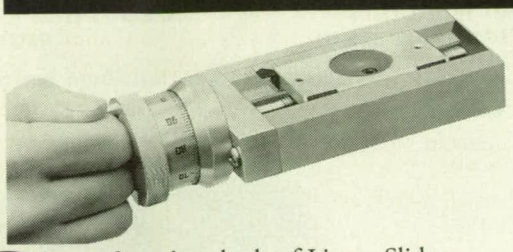
& HMI Workstations

MiTAC

MiTAC Industrial Corporation
1-800-648-2295
www.mitacinds.com

For More Information Circle No. 441

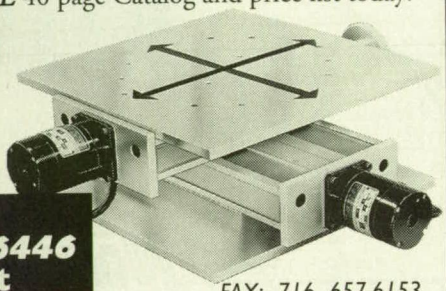
UniSlide® Precision Positioning Equipment



Choose from hundreds of Linear Slides, Rotary Tables, and X-Y Tables. Use them to position, gauge, scan or feed. Move loads from 1 oz. to 400 lbs. from 0.25 to 84". Program powerful motor controllers from your computer. Get your ***FREE*** 40 page Catalog and price list today!

VELMEX

Bloomfield, N. Y. 14469



Call 800 642-6446 or visit www.velmex.com

FAX: 716 657-6153
In NYS: 716 657-6151

For manual applications circle 473
For motorized applications circle 474

ENERGY ABSORBTION?

Sorbothane® Rules!

Isolation Components & Solutions

Sorbothane manufactures isolation components that absorb shock and isolate vibration. No other material can absorb, dampen or dissipate as effectively using less space and less material. And Sorbothane performs consistently over various temperatures and frequencies. Call for a prototype sample and a new brochure detailing Sorbothane's properties and innovative applications. **800.838.3906**

Sorbothane Inc.

2144 State Route 59, Kent, Ohio 44240 • tel 330.678.9444 fax 330.678.1303
www.sorbothane.com

LTI Approach to Adaptive Narrow-Band Feedforward Control

A necessary and sufficient condition for closed-form LTI representation has been discovered.

NASA's Jet Propulsion Laboratory, Pasadena, California

A unified theory of linear time-invariant (LTI) representations has been developed for use in the analysis and design of adaptive, narrow-band, feedforward controllers for systems characterized by harmonic regressors (the term "harmonic regressor" is defined below). Such controllers are used, for example, to suppress harmonic noise and vibrations; the basic idea is to track disturbance tones actively and "notch" them by use of high-gain feedback to achieve large attenuation. The LTI approach embodied in the unified theory makes it possible to apply established LTI theoretical concepts to the adaptive-feedforward-control design problem, and thus to design stable, high-performance controllers while avoiding the complexities and risks associated with nonlinear and/or time-varying control loops.

It is necessary to explain some mathematical terms as a prerequisite to a summary of the unified theory. The figure schematically illustrates the relationships among the terms.

As part of the control problem, one seeks to obtain an estimate, $\hat{y}$, of some signal $y(t)$, where (t) signifies dependence on time. One constructs $\hat{y}$ as a linear combination of the elements of a regressor vector $\mathbf{x}(t)$; namely, $\hat{y} = \mathbf{w}(t)^{\mathrm{T}}\mathbf{x}(t)$, where T denotes the matrix transpose and $\mathbf{w}(t)$ is an N-dimensional parameter vector that is "tuned" in real time via an adaptation algorithm, the basic equation of which is described in the paragraph after the next one.

A system of the type to which this analysis applies is characterized by a harmonic regressor, among other things. A harmonic regressor is given by $\mathbf{x} = \mathrm{X}\mathbf{c}(t)$, where X is an N-by-$2m$ matrix and $\mathbf{c}(t)$ is a $2m$-dimensional vector of paired sinusoids and cosinusoids of arbitrary frequencies; namely,

$$\mathbf{c}(t) = [\sin(\omega_1 t), \cos(\omega_1 t), \ldots, \sin(\omega_m t), \cos(\omega_m t)]^{\mathrm{T}}.$$

The regressor vector $\mathbf{x}$ is filtered through $F(p)$ to obtain $\tilde{\mathbf{x}}$. The filtering operation is represented by

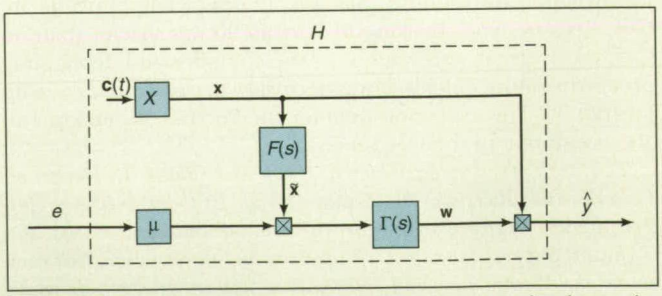
$$\tilde{\mathbf{x}} = F(p)[\mathbf{x}].$$

where p denotes the differential operator (replacing the Laplace s). The basic equation of the algorithm is

$$\mathbf{w} = \mu\Gamma(p)[\tilde{\mathbf{x}}(t)e(t)],$$

where $\mu > 0$ is an adaptation gain, $e(t)$ is an error signal, $\Gamma(p)[\cdot]$ denotes a filtering operation in the same way that $F(p)[\cdot]$ above denotes a filtering operation, and $\Gamma(p)$ is a multivariable LTI transfer function of the designer's choosing, representing the desired adaptation law.

Taken together, the foregoing equations define an open-loop mapping from the error signal e to the estimated output



The **Operator *H*** represents the mapping from the error signal *e* to the output in an adaptive system with harmonic regressor **x**, adaptation law governed by Γ(*s*), and regressor filter *F*(*s*).

For More Information Circle No. 458

A/E/C SYSTEMS® '98

IT for Design and Construction

What the

AEC World

is Coming To

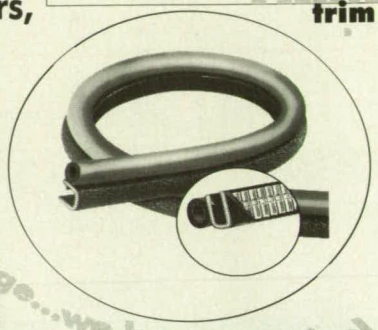
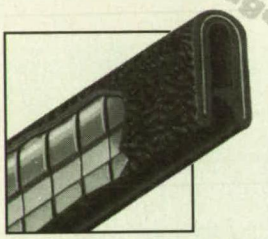
MORE PRODUCTS YOU NEED TO SEE

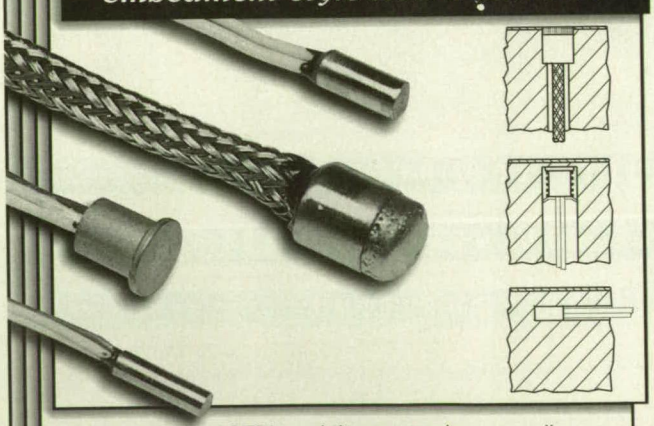
MORE PEOPLE YOU NEED TO MEET

MORE VALUE FOR YOUR TIME

Conference: June 2-5
Exhibit: June 3-5
McCormick Place

1-800-451-1196 • www.aecsystems.com • 1-800-451-1196 • www.aecsystems.com • 1-800-451-1196

TRIM-LOK® INC.
if you have an edge...we have a trim!
For over 25 years, the leader in flexible plastic and rubber extrusions!
trim


call for FREE samples
e-mail: trimlok@deltanet.com
call toll-free 1-888 TRIMLOK
714-562-0500 fax 714-562-0600
6855 Hermosa Circle Buena Park, Ca 90622-6180
For More Information Circle No. 442

Miniature Temperature Sensors
embedment style RTD's and TC's

Metal encased RTD's and thermocouples as small as 0.3" x 0.08" ϕ (7.6 x 2 mm ϕ) • Rugged construction with Teflon insulated wires or stainless steel braided cable • Spring-loading option
Monitor bearing condition — embed beneath babbitt layer for continuous sensing • Monitor & control machinery • Ideal where rugged probe style sensor is required in restricted space
MINCO PRODUCTS, INC.
7300 Commerce Lane • Minneapolis, MN 55432-3177 U.S.A.
Telephone: (612) 571-3121 • FAX: (612) 571-0927
For More Information Circle No. 443

$\hat{y}$. The mapping is represented by $\hat{y} = H[e]$, where H denotes the mapping operator. In general, H is a linear time-varying (LTV) operator, and this is where the unified theory makes a major contribution: The theory includes a theorem that provides a necessary and sufficient condition under which the overall effect of H can be represented exactly by an LTI operator, even though H may include time-varying elements. The condition is a result of the modulation and demodulation properties of products of the sinusoids contained in the harmonic regressors. The condition, called the "X-orthogonality" (XO) condition, is that the elements of X must be chosen so that X^TX is a block-diagonal matrix consisting of 2×2 matrices proportional to positive identity matrices. When the XO condition is satisfied, the LTI representation is specified by a closed-form analytic expression.

The theory is characterized as "unified" because it produces, as special cases, all known instances of LTI adaptive feedforward systems previously reported in the literature. The theory generalizes the previous results by showing this class of LTI adaptive systems to be considerably larger than it was known to be. The theory has also been specialized to adaptive systems, the regressors of which are formed by filtering signals through tapped delay lines (TDLs). TDLs can be implemented easily and are used in diverse adaptive signal-processing applications. It has been shown (under mild conditions) that an adaptive system becomes asymptotically LTI as the number of taps in the TDL is increased.

This work was done by David S. Bayard of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 147*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). NPO-20184*

Improved Design of Adaptive Feedforward Tracking Systems

Performances can be enhanced, without need for additional hardware.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved method of analysis and design offers the potential to enhance the performances of adaptive feedforward tracking systems. The method can, in principle, make it possible to increase such performance measures as rates of convergence and noise-cancellation ratios, without need for additional hardware. The method is applicable to communication systems, adaptive equalizers, adaptive systems for canceling noise from machinery, advanced vibration-suppressing systems, and echo-canceling systems. The method is particularly significant for overparameterized adaptive feedforward systems, which are very important in practice; they are used to ensure high-performance "tuning" of key signals in a wide range of terrestrial and outer-space applications, including the ones listed above.

It is necessary to explain some mathematical terms as a prerequisite to a summary of the improved method. In some respects, this explanation resembles the one in the preceding article, "LTI Approach to Adaptive Narrow-Band Feedforward Control" (NPO-20184); however, there are some differences, making it necessary to give a separate explanation here.

As before, one seeks to obtain an estimate, $\hat{y}$ of some signal $y(t)$, where (t) signifies dependence on time. One constructs

$\hat{y}$ as a linear combination of the elements of a regressor vector $\mathbf{x}(t)$; namely, $\hat{y} = \mathbf{w}(t)^{\mathrm{T}}\mathbf{x}(t)$, where T denotes the matrix transpose and $\mathbf{w}(t)$ is an N-dimensional parameter vector that is "tuned" in real time via an adaptation algorithm, the basic equation of which is described below. The regressor vector is given by $\mathbf{x} = \mathrm{X}\mathbf{c}(t)$, where X is an N-by-n matrix and $\mathbf{c}(t)$ is as described below. A system of the type to which the present analysis applies is one for which $N > n$; this is what is meant by "overparameterized" in the present context.

One constructs a suitable stable time-domain filter operator $F(p)$, where p denotes the differential operator (replacing the Laplace s for all time-domain interpretations). The regressor vector $\mathbf{x}$ is filtered through $F(p)$ to obtain $\tilde{\mathbf{x}}$. The filtering operation is represented by

$$\tilde{\mathbf{x}} = F(p)[\mathbf{x}].$$

The basic equation of the adaptation algorithm is

$$\mathbf{w} = \mu\Gamma(p)[\tilde{\mathbf{x}}(t)e(t)],$$

where $\mu > 0$ is an adaptation gain, $e(t)$ is an error signal, $\Gamma(p)[\cdot]$ denotes a filtering operation in the same way that $F(p)[\cdot]$ above denotes a filtering operation, and $\Gamma(p)$ is a multivariable LTI transfer function of the designer's choosing, representing the desired adaptation law.

The vector $\mathbf{c}(t)$ is not the same as in the preceding article. Instead, $\mathbf{c}(t)$ in this case is an n-dimensional vector of piecewise-continuous signals that satisfies a condition called the "persistent excitation" (PE) condition, defined as follows: Let there be positive constants β_1, β_2, and T_0, and a suitably dimensioned identity matrix, I, such that

$$\beta_1 \mathrm{I} \le \int_t^{t+T_0} \mathbf{c}(\tau)\mathbf{c}^{\mathrm{T}}(\tau)d\tau \le \beta_2 \mathrm{I}$$

for all $t \ge 0$. If any signal vector $\mathbf{c}(t)$ satisfies these criteria, it is said to be persistently exciting (PE) with bounds $\{\beta_1, \beta_2, T_0\}$. This completes the explanation of terms.

In the theoretical analysis on which the improved method is based, attention is focused on two matrix products; the confluence matrix (defined as $\mathrm{X}^{\mathrm{T}}\mathrm{X}$) and the autocorrelation matrix (defined as $\mathrm{X}\mathrm{X}^{\mathrm{T}}$). This analysis reveals that the older methods based on the autocorrelation matrix and associated PE conditions are overly stringent for ensuring exponential convergence of the tracking error in an overparameterized adaptive feedforward system. Indeed, when an adaptive system is overparameterized, the PE condition is never satisfied, and therefore the older methods do not provide any clue as to the performance of the final adaptive design, much less provide guidelines on how to improve performance.

The analysis reveals, further, that if the confluence matrix is positive definite, then the adaptive feedforward operator H from the error e to the estimate is input-output equivalent to an adaptive system with a PE regressor; this implies that the tracking-error convergence is exponential for a large class of overparameterized adaptive feedforward systems. Thus, the positive-definiteness condition for the confluence matrix, which is easily satisfied, supplants the positive-definiteness condition for the autocorrelation matrix, and thus constitutes the theoretical basis of the improved method. The analysis also shows that the only penalties for overparameterization are that (1) the optimal exponential rate of convergence of tracking error is degraded by the condition number of the confluence matrix and (2) the parameter errors converge exponentially on a reduced subspace rather than over the entire space.

This work was done by David S. Bayard of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 120*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). NPO-20183*

Paroscientific, Inc.
Digiquartz® Pressure Instrumentation

Features:
- **0.01% Accuracy**
- 1x10^{-8} Resolution
- Digital Output Signal
- Environmentally Rugged
- High Reliability & Stability
- ISO 9001 Quality System
- 5 Year Extended Warranty

Products:
- Barometers
- Transducers
- Transmitters
- Depth Sensors
- Portable Standards
- Fiber-Optic Systems
- Water Stage Sensors
- Meteorological Systems

4500 148th N.E., Redmond, WA 98052
Tel: (425) 883-8700 Fax: (425) 867-5407
Internet: http://www.paroscientific.com

For More Information Circle No. 444

SEALING SOLUTIONS FOR THE TOUGHEST ENVIRONMENTS

- Uncompromising sealing performance
- For oil, gas chemical, and processing applications
- Operational temperatures: -400° to 575°F
- Seals dynamic applications up to 100,000 psi
- Suited to operation in the most aggressive media
- For piston, rod, rotary and special applications
- Offers high stability and very long service life

VARISEAL™

Visit us at the Busak + Shamban Booth #8125

Busak+Shamban

For more information
Call: 1-800-466-1727
Fax: 1-303-469-4874
web: www.variseal.com

Variseal™ is manufactured within the Busak+Shamban Group by American Variseal

For More Information Circle No. 445

Books & Reports

Flexible Actuators for Small, Mobile, Special-Purpose Robots

A report discusses flexible microactuators for a proposed generation of small, mobile, special-purpose robots. Aspects of this topic were discussed in two previous articles in *NASA Tech Briefs*: "Thin-Film, Light-Energized Bimorph Micromechanical Actuators" (NPO-19607), Vol. 20, No. 8 (August 1996), page 11a and "Tetherless, Optically Controlled Nanorovers" (NPO-19606), Vol. 21, No. 3 (March 1997), page 92. To recapitulate: insectlike robots equipped with microsensors and/or micromanipulators are proposed for use in applications as diverse as remote exploration, surgery, and surveillance. These robots would move by the electronically and/or photonically controlled bending of flexible cantilever-beam bimorph microactuators (composites of thin piezoceramic films on strong polymeric substrates) that would be analogous to animal limbs except that they would not be jointed. The report emphasizes that in comparison with other actuators with equal areas, the proposed microactuators would offer high ratios of generated force to input power, and that unlike actuators micromachined from silicon, the proposed microactuators would not be restricted by the clamping effects of substrates. The report reviews the state of the art, discusses the principles of operation and the rationale for using the microactuators, describes potential applications, and proposes research to develop advanced piezoceramic materials for microactuation.

This work was done by Sarita Thakoor and Jim Cutts of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Flexible Micro-Actuators for Advanced Mobility," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 108*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). NPO-20019*

Development of Small, Mobile, Special-Purpose Robots

A report presents a scenario for the proposed development of insectlike robots that would be equipped with microsensors and/or micromanipulators, and would be designed, variously, to crawl, burrow, swim, fly, or hop, to perform specific tasks in fields as diverse as exploration, micropositioning, and surgery. In part, the report reiterates and extends previous discussions of this concept from a number of previous *NASA Tech Briefs* articles and supporting documents, including those mentioned in the immediately preceding article. One notable feature not mentioned previously is a proposed hierarchical scheme in which insectlike exploratory robots would communicate with fewer larger, more-complex robots, and so forth up a hierarchy to a central robot or instrumentation system. The report discusses the historical background of the concept, presents an overview of the uses and functions of the robots, describes the objective and justification for a program of research and development, and summarizes the potential technological and economic advantages offered by the proposed robots. The report goes on to discuss the advanced fabrication, actuator, computer, sensing, computing and power-supply technology that must be developed and refined to implement insectlike mobility and functionality for various robotic tasks. A list of tentative development goals is presented; the final goal in this list is the demonstration of an insectlike exploratory robot in the year 2001 and beyond.

This work was done by Sarita Thakoor of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Insect-Explorer Technology Development: Exploration of New/Hazardous Territory," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category,* ***or circle no. 109*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). NPO-20267*

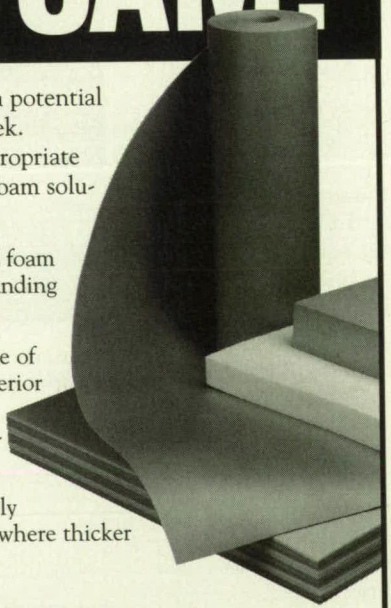
Design Challenge?
THINK FOAM!

If you're thinking about polyolefin foam as a potential solution to your design problem, think Voltek. We're committed to providing the most appropriate and highest-quality crosslinked closed-cell foam solution for your application.

Volara® is a fine-celled, irradiation crosslinked foam that offers aesthetic appeal as well as an outstanding range of performance characteristics.

Volextra®'s extrusion coating adds a wide range of aesthetic and performance qualities to the superior properties of Volara, providing a decorative advantage and allowing for the design of high-performance composites.

Minicel® is an extremely fine-celled, chemically crosslinked foam that is ideal for applications where thicker sections are required.

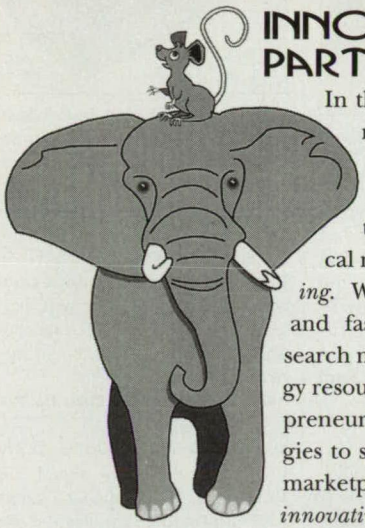


To find out more, or to receive a free "Thought Starter," call (800) 225-0668 or fax (978) 685-9861.

Voltek
Division of Sekisui America Corporation
100 Shepard Street Lawrence, MA 01843
email: prodinfo@voltek.com

FEDLABS FORUM

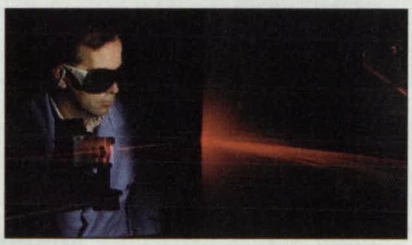
News from the Federal Laboratory Consortium for Technology Transfer (FLC) — the nationwide network of federal labs that provides the forum to develop strategies and opportunities for linking technology with the mission and the marketplace.



INNOVATIVE PARTNERS

In the FLC's dialogues with reps from industries, trade associations and small businesses, you've told us your technological needs. And we are *listening*. We're working smarter and faster to *match* your research needs with our technology resources and develop entrepreneurial, cost-efficient strategies to speed technology to the marketplace. Our efforts and *innovative partnerships*—sometimes "odd-couples"—have produced vital, useful processes and products, in all areas. In manufacturing and materials, for example, we have both technology successes and partnering opportunities...

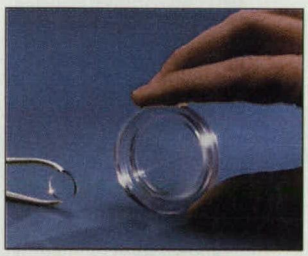
Glad Rags...US textile and garment industries may become more globally competitive thanks to new diagnostic techniques developed in fusion energy research at Princeton Plasma Physics Laboratory. PPPL's process measures the physical and chemical properties of textile fibers online, allowing process adjustments to be made *immediately*, as textile factories do not have to stop the manufacturing process to remove samples for off-line analysis. Saving both time and money, PPPL's technique also expands the number of properties measurable for monitoring the important fiber characteristics during production.



In a cooperative research and development agreement, PPPL is working with Princeton Textile Research Institute (a member of the government-industry partnership AmtrexLab, with many leading textile/apparel manufacturers) to develop instruments and data analysis techniques for use in real-time, non-contact, optical and spectroscopic techniques. (**Anthony R. De Meo**, 609/243-2755)

Material Rewards... New technologies in materials and manufacturing were honored in the annual FLC Technology Transfer Awards and the RIB-IT Program—offering current chances for industry buy-in:

Fantesk is an oil-water-starch combination that helps prevent soil erosion in furrow-irrigated farm fields and reduce the growth of harmful bacteria in poultry developed by Agriculture Research Service scientists. Transferred via 5 CRADAs, Fantesk originally was a completely digestible fat replacement for use in a broad range of foods, and has potential in products ranging from seed coatings, non-toxic adhesives and oil drilling mud additives to bases for cosmetics and pharmaceuticals. (**Ben Hardin**, ARS, 309/681-6597)



Sol-Gels, a three-step, gel-forming process to mold glasses and glass-ceramics, eliminates the high-temperature furnace required for fused quartz glass products and produces optical silica in quantity in less time, for less money, while retaining product quality. Sol-Gels is for large, diverse markets using micro-optics. (**Ramesh Krishnaiyer**, NASA Southeast Regional Technology Transfer Center, 561/297-2951)

Coated Carbon Foams is a lightweight, thermally insulating, shock resistant, electrically-conductive, stable-to-high-temperatures material that can be coated with over 150 different materials, for potential uses in the construction, aerospace, auto and biomedical industries. (**Martin Zeller**, NASA Far West Regional Technology Transfer Center, 213/743-2927)

Null Convention Logic, a paradigm shift in design, results in faster/smaller/more cost-effective manufacturing of integrated circuits, eliminating the clock function of the IC, and replacing Boolean logic. NCL offers "a clear path to gigahertz asynchronous logic" with greater advantages in manufacturing technology. (**Dr. Richard A. Callahan**, Center for Technology Commercialization, 508/870-0042)

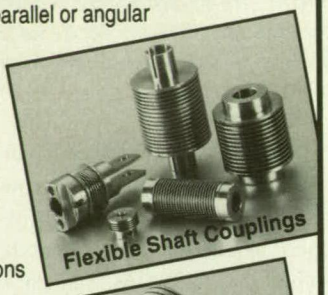
March Manufacturing Expo '98... Mark the date and place—March 24-26, Greenville, SC. The Automated Manufacturing Exposition is prime for leads and new contacts, potential customers, partnerships or what's new in industrial automation technologies. A good place to start is at the FLC booth. Stop by, say hi! Our FLC reps and locator will connect you with technical experts in your field, helpful contacts, potential customers or *partnerships*—from our federal labs and agencies.

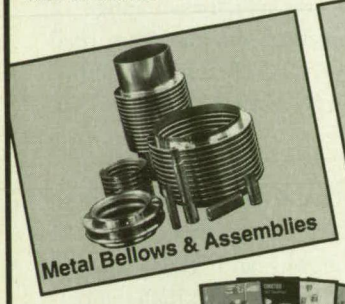
SERVOMETER®

Specialists in Miniature Bellows Couplings • Contacts • Electroforms

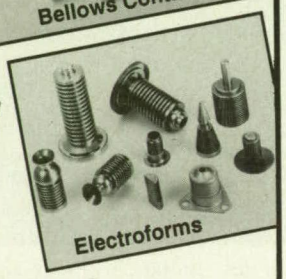
Whether your problem is one of parallel or angular misalignment; tolerance build-up or electrical continuity; extreme sensitivity and accuracy or close tolerance and high strength... Servometer has the solution.

Our highly qualified engineering staff will support you from your initial conceptual design through project completion. Stock selections also available.





Call or write for free brochures



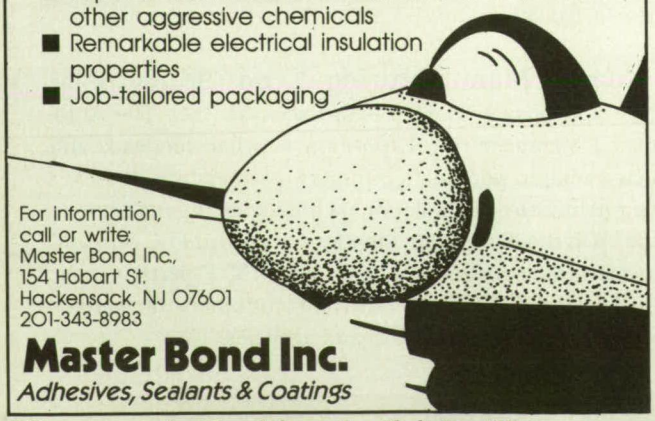
Servometer Corporation
501 Little Falls Rd.
Cedar Grove, NJ 07009
(973) 785-4630 • Fax: (973) 785-0756 • www.servometer.com

For More Information Circle No. 447

STRUCTURAL ADHESIVE RESISTS UP TO 500°F

MASTER BOND POLYMER SYSTEM EP34CA

- Excellent bond strength to similar and dissimilar substrates
- 100% reactive, does not contain solvents or other volatiles
- Low viscosity assures convenient application
- Simplified thermal cure schedules
- Highest physical strength properties
- Outstanding dimensional stability and durability
- Superior resistance to water, fuels, lubricants and other aggressive chemicals
- Remarkable electrical insulation properties
- Job-tailored packaging

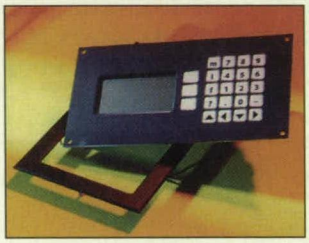


For information, call or write:
Master Bond Inc.,
154 Hobart St.
Hackensack, NJ 07601
201-343-8983

Master Bond Inc.
Adhesives, Sealants & Coatings

For More Information Circle No. 448

New on the Market



Z-World, Davis, CA, has introduced the PK2400 C-programmable **controller** for machine control, embedded systems, and OEM control applications. It offers nine protected digital inputs, two conditioned analog inputs, six high-current outputs, two non-latching relays, and two serial ports, and allows connection directly to photosensors, temperature and pressure sensors, strain gauges, and other devices.

For More Information Circle No. 731

Validyne Engineering, Northridge, CA, has introduced a spreadsheet **data logger** that provides real-time digital display of analog signals in an Excel® spreadsheet. The logger consists of a PC interface, cable, terminal block, and Windows software. Features include up to 24 channels of analog, a macro scripting utility that automatically prints and saves spreadsheets and graphs, and the ability to fax or e-mail graphs and spreadsheets.

For More Information Circle No. 728

The PRM-100 Precision Rate Meter from Advanced Research Instruments Corp., Boulder, CO, is a **data acquisition system** based on a 100MHz counter and crystal-controlled timer with digital and bar graph displays. The system features a digital-to-analog conversion to drive a strip chart recorder or X-Y recorder and an optional computer interface for automated data acquisition and processing compatible with most computers.

For More Information Circle No. 730

The Gemini Series of **single-board computers** from Synergy Microsystems, San Diego, CA, is available in single or dual 603e, 604e, 740, 750, or 760 CPUs running at up to 300+ MHz. The PowerPC boards support true VME read-write-modify cycles in hardware, and provide data access across the VME bus. They offer up to 256 MB of synchronous DRAM, with optional ECC.

For More Information Circle No. 726

Immersion Corp., San Jose, CA, has announced the FEELit Mouse™ **mouse-style interface** that adds the sense of touch to computer interaction. Users can feel the weight of an icon when dragging it across the screen; feel textures, surfaces, liquids, and other physical sensations when scanning over a web page; and feel a rubber-band-like sensation when stretching a line in an engineering drawing.

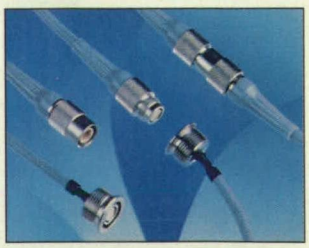
For More Information Circle No. 721

Danaher Controls, Gurnee, IL, has introduced the Eagle Signal B506 **LED timer**, a four-digital dual-line LED display that indicates the present time value and the setpoint while up to eight annunciator lights display process status. The front-panel interface has a button-per-digit keypad for input of setpoint. Multi-level security is provided to prevent unauthorized changes. Three models are available: standard, high-performance, and repeat cycle.

For More Information Circle No. 720

The Symbion Pro3200LX Windows NT **workstation** from MaxVision Corp., Huntsville, AL, offers configurations for single or dual 300-MHz Intel processors and MMX™ technology, as well as the Accelerated Graphics Port (AGP) graphics-enhanced bus architecture. The workstation features five PCI slots, two ISA slots, and one AGP slot, and can be configured with up to 512 MB of memory and 54GB of internal storage.

For More Information Circle No. 722



Omnetics Connector Corp., Minneapolis, MN, has introduced lightweight **metal connector housings** for microminiature circular connectors that feature an O-ring for a watertight seal. Termination options include wire-to-wire and wire-to-board. Panel-mount hardware is available for I/O applications, and the connectors conform to MIL-C-83513C.

For More Information Circle No. 723

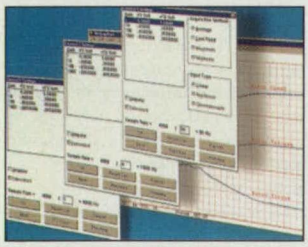
New on Disk

Transom Technologies, Ann Arbor, MI, has introduced Transom™ Jack® (TJ™) Version 1.2 **human-modeling and behavioral-simulation software** that features enhanced ability to use CAD/CAM data; simulate people interacting with machines and workspaces; and communicate analysis results. The software automates the process of taking models directly from Pro/ENGINEER into the Transom simulation environment.

For More Information Circle No. 701

Reticular Systems, San Diego, CA, has introduced AgentBuilder™ **intelligent agent software** toolset that provides tools and facilities for developing intelligent software agents and agent-based applications. It accommodates application-domain analysis, problem decomposition, agent definition, and agent programming for the Internet, electronic commerce, and office automation.

For More Information Circle No. 700



DATAQ Instruments, Akron, OH, has announced WinDaq/Pro+ **data-acquisition software** for PC-based waveform data recording. It offers the capability to tailor sample rate on a per-channel basis by selecting sample rate divisor values of 1 to 255. Other features include disk streaming up to 500 ksamples per second; multitasking operation; and recording of up to 240 channels and display of up to 32 channels simultaneously.

For More Information Circle No. 704

NPO Power Systems, Atco, NJ, has released "The Book of All Knowledge for Electrical Engineers and Power Supply Designers," **interactive reference software** that combines several reference books into one manual. Features include standard resistor values; safety spacing requirements; and references for computer-aided, analog, and power-supply design. The software runs on Excel™ versions 5, 95, and 97.

For More Information Circle No. 707

Able Software Co., Lexington, MA, has released version 3.0 of its R2V **raster to vector conversion software**, which includes fully automatic vectorization, and semi-automatic interactive line tracing from scanned maps and other raster image sources. Other features are a batch script tool for programming, and export vector file formats such as AutoCAD DXF, MapGuide SDL, and 3-D XYZ.

For More Information Circle No. 706

Robot Off-Line Teaching System of Yaskawa (ROTSY) Version 4.2 **robotic simulation software** from Motoman, West Carrollton, OH, can model a proposed robot cell and perform test cycles before building. Running under Windows 95 and NT, the program features 3D design for modeling and layout of robot cells with peripheral equipment; import of DXF, DWG, IGES, STEP, and other files; and 3D surface display.

For More Information Circle No. 705

FlatOut! **AutoCAD® converter software** from Tailor Made Software, Kent, WA, converts AutoCAD R12 files to 17 different Web, CAD, and technical-illustration formats, including Drawing Web Format (DWF), Portable Data Format (PDF), and Computer Graphics Metafile (CGM). It runs on Windows NT/95/3.1x.

For More Information Circle No. 702

Data Physics Corp., San Jose, CA, has released DP550Win Version 3.0 **vibration-control software** that features fatigue testing in Sine control; an enhanced production test feature set in Shock and Transient; and SRS testing for compliance with the Bellcore standard for earthquake, office, and transportation vibration. Applications include automotive, aerospace, consumer electronics, and communications industries.

For More Information Circle No. 703

Patriot Sensors and Controls introduces a new line of pressure transducers for aircraft applications, featuring sensor technology that's a step ahead of other pressure transducer designs.

Highlights:

Static Accuracy: ±0.1% FS

Absolute Accuracy: less than ±1.5% FS (within compensated temp range, includes all errors)

Insulation Resistance: ≥100 Mohm at 500 VDC

Operating Temp: -65 to 250°F, wider ranges available

Certifications: FAA - TSO & CAA Certified Units

Service: FAA, JAA Authorized Repair Center

PATRIOT SENSORS & CONTROLS

Tel: 800.581.0701
Fax: 805.583.1526
www.xducer.com

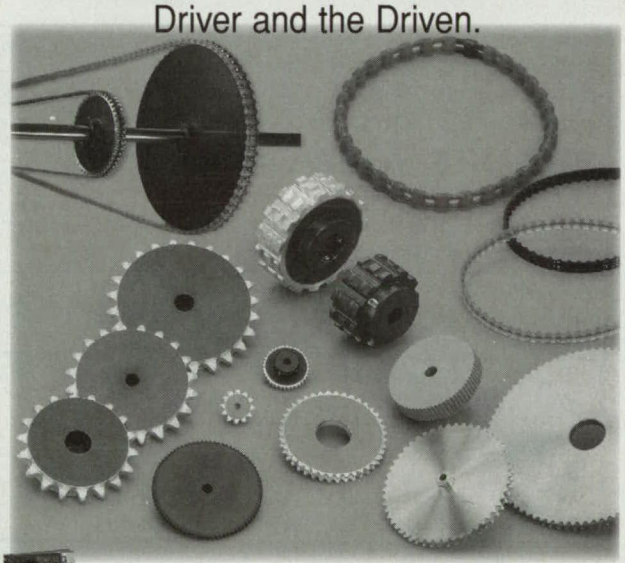
LOOKING FOR

...High Accuracy?
...Low Cost?
...Long Term Stability?
...High Insulation Resistance?

We proudly present:
Silicon on Sapphire
Pressure Transducers

For More Information Circle No. 449

For Power Transmission and Linear Component Products
BERG supplies everything between the Driver and the Driven.



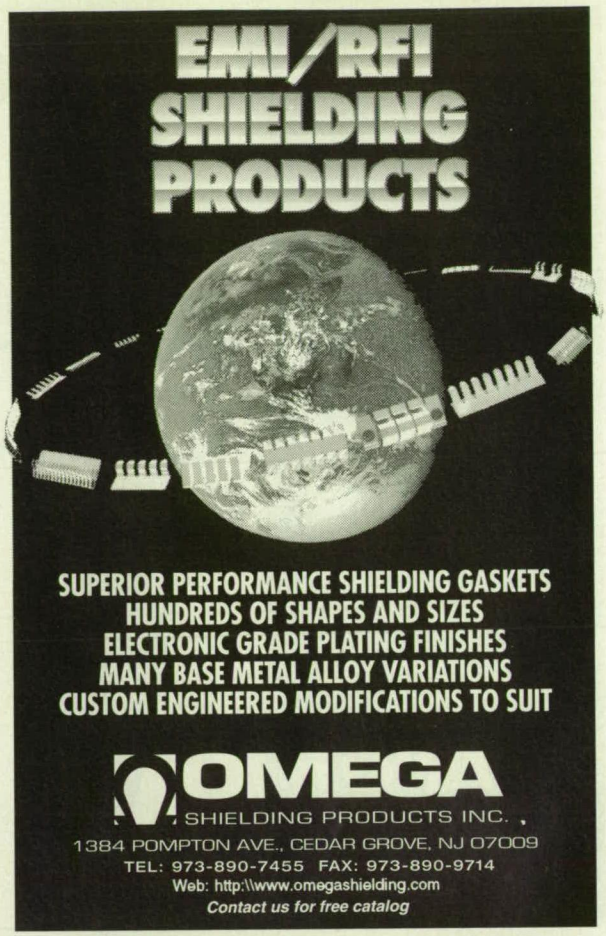
We are the only company that offers guaranteed deliveries on production lots of gears, sprockets and belts. We guarantee it! and
You don't pay the freight if we ship the product late.

We can deliver and stock for your needs. Call for a free inch (B97) and metric (M97) Catalog, Product Bulletins or a Special Quote on your scheduled delivery needs.

TEL: 1-800-232-BERG
FAX: 1-800-455-BERG
Web Address www.wmberg.com

BERG
W. M. BERG, INC.
PRECISION MECHANICAL COMPONENTS
499 Ocean Avenue, East Rockaway, NY 11518

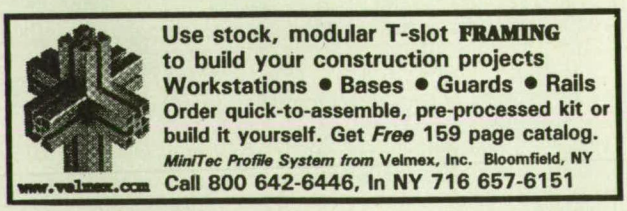
For More Information Circle No. 450



For More Information Circle No. 451

The Technology Connection

To Advertise Call (800) 944-NASA



NASA Tech Briefs, ISSN 0145-319X, USPS 750-070, copyright© 1998 by Associated Business Publications Co., Ltd. Copyright is not claimed for the individual "tech briefs" contained in this publication. The U.S. Government has a paid-up license to exercise all rights under the copyright claimed herein for government purposes. NASA Tech Briefs is published monthly by Associated Business Publications Co., Ltd., 317 Madison Ave., New York, NY 10017-5391. Editorial, sales, production and circulation offices at 317 Madison Ave., New York, NY 10017-5391. Subscription for non-qualified subscribers in the U.S., Panama Canal Zone, and Puerto Rico, $75.00 for 1 year; $135.00 for 2 years; $200.00 for 3 years. Single copies $10.00. Foreign subscriptions one-year U.S. Funds $195.00. Remit by check, draft, postal, express orders or VISA, MasterCard, or American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to NASA Tech Briefs, 317 Madison Ave., New York, NY 10017-5391.

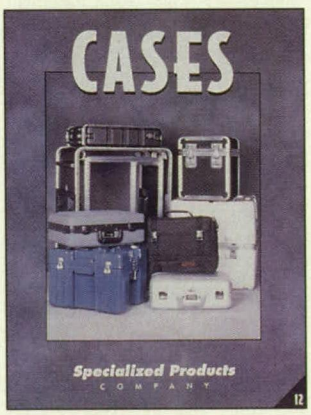
New Literature

Intergraph Corp., Huntsville, AL, offers a brochure describing Imagineer Technical Version 2.0 **2-D CAD software** for Windows 95, NT 4.0, or later. Features include AutoCAD and MicroStation compatibility, and collaboration via Internet.

For More Information Circle No. 708

A brochure from VisiCom Laboratories, San Diego, CA, describes products and services related to **embedded real-time systems** for commercial and military applications. Included are device drivers for fiber optics, storage technologies, and single-board computer support.

For More Information Circle No. 715



Specialized Products, Southlake, TX, has released a 32-page catalog featuring **shipping containers** in more than 100 configurations, including watertight hard-shell and padded soft-side styles. Applications include carrying and protecting tools, science instruments, and portable computers.

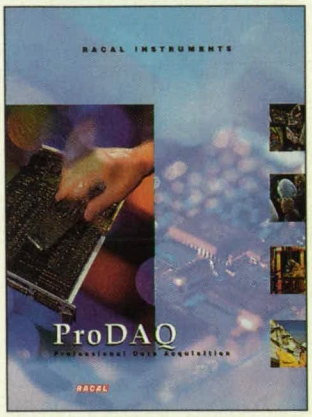
For More Information Circle No. 714

An engineering design manual available on CD-ROM from the Corzan Industrial Systems division of BFGoodrich, Cleveland, OH, describes Corzan™ **industrial pipe and fittings**. Ducting systems, sheet/lining, and fabrication are included.

For More Information Circle No. 712

A brochure from Control Engineering, West Springfield, MA, describes Series DLR **electronic sensors** for controlling pumping operations in liquid tanks. The sensors are designed for applications requiring maintenance of liquid levels between two probe heights.

For More Information Circle No. 711

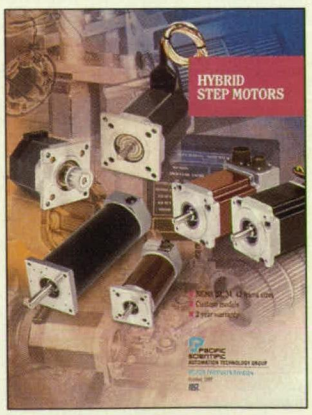


Racal Instruments, Irvine, CA, has released a brochure describing the 6700 Series ProDAQ VXIbus motherboard and function-card **data acquisition systems**. By providing an internal ProDAQ bus, the VXIbus motherboard has eight internal ports for user configuration.

For More Information Circle No. 709

A 20-page catalog from Magtrol, Buffalo, NY, describes **motor-testing equipment** ranging from manually operated dynamometers to customized PC-based systems. Products include small gas-engine dynamometers; enhanced power analyzers; and temperature-testing software.

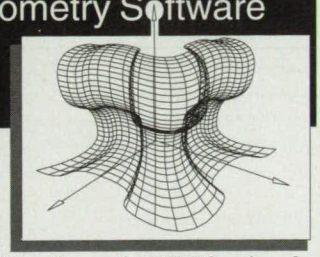
For More Information Circle No. 710



A catalog from Pacific Scientific's Motor Products Division, Rockford, IL, features POWERMAX II® and POWERPAC™ **stepper motors**, and POWERSYNC™ AC synchronous motors and planetary gearheads. Also described is OPTIMIZER™ 2.0 Windows software for motor selection.

For More Information Circle No. 713

NURBS Geometry Software



Nlib 3.0 is a library of ANSI C functions for creating and processing NURBS curves and surfaces. The functions are easy to call and no knowledge of NURBS mathematics is required. Nlib 3.0 is the ideal kernel upon which to build geometry-based applications. Source code, multi-users, no royalties. Maintenance, consulting and training.

http://www.gower.net/geomware

GeomWare, Inc. PH/FAX 903 839-5042

For More Information Circle No. 580

ROLYN OPTICS COMPANY

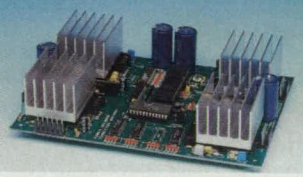
FREE! 130 Page Catalog

"Optics for Industry"

Free 130 page product catalog from Rolyn, world's largest supplier of "Off-the Shelf" optics. 24-hour delivery of simple or compound lenses, filters, prisms, mirrors, beamsplitters, reticles, objectives, eyepieces, plus thousands of other stock items. Rolyn also supplies custom products and coatings in prototype or production quantities. ROLYN OPTICS Co., 706 Arrowgrand Circle, Covina, CA 91722-2199, (626)915-5707, FAX (626)915-1379

For More Information Circle No. 581

Miniature Motion Systems . . . Ready to Step !



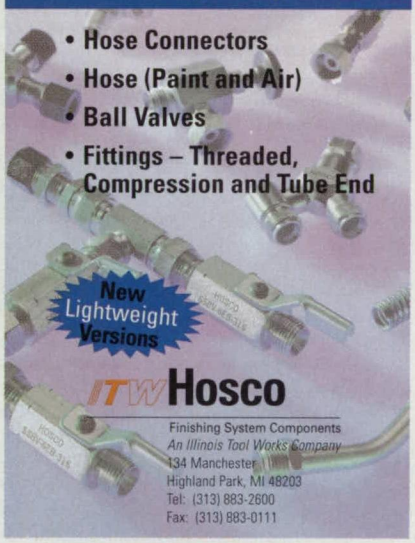
MMC systems provide 2 to 8 axes of mini-stepping, 2 amp., 40 volt drivers. CY545 controller features 16 million steps of ramped, high-speed, absolute motion. RS-232 serial port. Optical slip-detection. 100% accuracy. Network up to 256 axes/port. Dimensions 6″x7″x2″ (with enclosure 7″x11″x3″)

TMG
the motion group
800 - 424 - STEP

For More Information Circle No. 582

Your Coatings Experts for

- Hose Connectors
- Hose (Paint and Air)
- Ball Valves
- Fittings – Threaded, Compression and Tube End

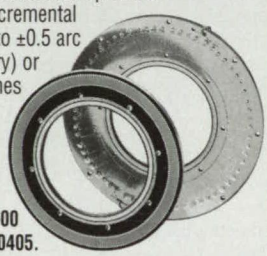


ITW Hosco
Finishing System Components
An Illinois Tool Works Company
134 Manchester
Highland Park, MI 48203
Tel: (313) 883-2600
Fax: (313) 883-0111

For More Information Circle No. 583

POSITION ACCURACY to ±0.5 arc second!

Inductosyn® transducers provide absolute or incremental position data to ±0.5 arc second (Rotary) or ±40 microinches (Linear). Resolution to 26 bits.



For brochure, call 914/761-2600 or fax 914/761-0405.

FARRAND CONTROLS
DIVISION OF RUHLE COMPANIES, INC.
99 Wall Street, Valhalla, NY 10595

For More Information Circle No. 584

Flexible Bladders

NASA Qualified

- BLADDER TANKS & AIR CELLS
- DIAPHRAGMS & ACUATORS
- BELLOWS & FUEL CELLS
- STRESS TEST BLADDERS
- CUSTOM INFLATABLES
- PNEUMATIC / HYDRAULIC PRESSES

ATL 800-526-5330
AERO TEC LABORATORIES INC.
RAMSEY, NJ 07446-1251 USA
TEL: 201-825-1400 • FAX: 201-825-1962
e-Mail aerotec@cybernex.net
http:// www.atlinc.com

For More Information Circle No. 585

Mars T-Shirt

Colorful rendition of Mars Pathfinder Superimposed dramatically on back of black or white shirt. Mission logo on front left. 100% Cotton. Adult M, L, XL, or XXL. (Indicate Color of shirt when ordering.)

$14.95 U.S. plus $5.00 shipping and handling.
Mail payment to: NASA Tech Briefs, Dept F
317 Madison Ave., New York, NY 10017 U.S.A.
For credit card orders call (212)490-3999

DEHUMIDIFY . . .

SUPER DRY 5~30%
Ceramics - Museum pieces
Semiconductors - Pharmaceuticals
Chemical powders - Precision molds, parts

AUTO DRY 30~50%
Compact discs - Magnetic tapes, discs
Film, photographs, stamps - Precious metals
Wrist watches - Mechanical, electromechanical parts
Cameras, lenses, optical instruments

Economical, efficient, and affordable.
Sizes from 15 3/4 x 17 1/4 x 15 to 48 x 72 x 26

Patented, innovative process eliminates dessicant replacement.

ED-50S

PRESERVE VALUABLES FOR CENTURIES.

CUI STACK **800-275-4899** FAX: (503)643-6129
CUI Stack Inc., 9615 SW Allen Blvd. #103, Beaverton, OR 97005

On top of it.™

For More Information Circle No. 586

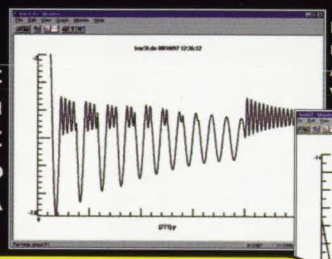
Advertisers Index

Company	Web Site	Circle Number	Page
A/E/C Systems '98	www.aecsystems.com		103
ACR Systems Inc.	www.acrsystems.com	433	92
Adaptive Research	www.adaptive-research.com	555	41
Aero Tec Laboratories	www.atlinc.com	585	111
Algor, Inc.	www.algor.com	510, 619, 620, 682, 506	7, 83, 20N-21N, COV III
Altair Computing Inc.	www.altair.com	522, 674	99, 22N
Alusuisse Alesa		435	96
American Variseal	www.variseal.com	445	105
AMETEK U.S. Gauge	www.ametek.com	614	83
AMP Incorporated	www.amp.com	563	53
Amtec Engineering	www.amtec.com	415	54
Ansoft Corporation	www.ansoft.com	470	37
ANSYS	www.ansys.com	579, 696	43, 11N
APD	www.algor.com	617, 618	83
ARRK	www.arrk.com/~arrsd/	417, 685	57, 24N
Astro-Med, Inc.	www.astro-med.com	560	75
Autodesk, Inc. Mechanical Desktop	www.autodesk.com/s467		9
Avery Dennison Corporation		528, 669	93, 19N
Axsys Technologies	www.axsysmcd.com.	428	78
Barksdale, Inc.	www.barksdale.com	408, 409	68
Belt Technologies	www.BeltTechnologies.com	678	23N
W.M. Berg, Inc.	www.wmberg.com	450	109
Betatronix, Inc.	www.betatronix.com	454	7a
Cabletest International, Inc.	www.cabletest.com	477-480	3a
Canon	www.usa.canon.com	569	81
Cardinal Aluminum Co.		420, 688	62, 24N
Ciba Specialty Chemicals		512	67
Clippard Instrument Laboratory, Inc.	www.clippard.com	621-630	49
Compaq Computer Corporation	www.compaq.com/products/workstations	516	2-3
CUI Stack	www.cuistack.com	586	111
Data Instruments		504, 681	71, 10N
Digi-Key Corporation	www.digikey.com	533	5
Dolch Computer Systems, Inc.	www.dolch.com	518, 686	4, 3N
DuPont Vespel	www.dupont.com/enggpolymers	529	20-21
Enterprise Software Products, Inc.	www.femap.com	558, 692	45, 14N
Equipto Electronic Corp.	www.equiptoelec.com	805	13a
Ergotron	www.ergotron.com	416, 679	56, 23N
The Evans Capacitor Company	www.evanscap.com	419	60
Farrand Controls		584	111
Fed Labs Forum		508	107
Fieldworks Inc.	www.field-works.com	430	86
Fort Wayne Anodizing		437	94
Gage Applied Sciences Inc.	www.gage-applied.com	545, 695	27, 18N
Galil Motion Control	www.galilmc.com	611	83
Gems Sensors Inc.	www.gemssensors.com	613	83
GeomWare, Inc.	www.gower.net/geomware	580	111
Geotest, Inc.-Marvin Test Systems		457	COV IIa
Gould Instrument Systems	www.gouldis.com	517	91
Helical Products Company, Inc.	www.Heli-Cal.com	426	74
Hewlett Packard Company Technical Computing Systems	www.hp.com/go/mdatools	671	28-29, 13N
Hewlett-Packard Basic Instruments	www.hp.com/info/info/bidaq1	521	32A-B, 33
Hewlett-Packard Vee			24A-B
Hitachi Denshi America, Ltd.	www.hdal.com	423	40
Integrated Systems, Inc.	www.isi.com	429	70
Intergraph Solid Edge	www.solid-edge.com	570, 697	39, 7N
Intergraph Computer Systems	www.intergraph.com/ics	548, 690	55, 5N
Intergraph Corporation	www.intergraph.com/imagine	574, 670	95, 12N
Interpoint	www.interpoint.com/tba	546	77
Invention Machine	www.invention-machine.com	524, 689	35, 2N
IOtech, Inc.	www.iotech.com	401-405	64A-B
ITWHosco		583	111
Keithley	www.keithley.com	588	80A-B
Keithley Instruments, Inc.	www.keithley.com	471	47
Kevex X-Ray	www.kevex-x-ray.com	421	63
Kingston Technology Company	www.kingston.com/storage	525	31
LaVezzi Presicision, Inc.		422	64
Lockheed Martin		540	50-51
LPKF Cad/Cam Systems Inc.	www.lpf.com	461	12a
Master Bond Inc.		448	108
Mathsoft, Inc.	www.mathsoft.com	554	61
The MathWorks, Inc.	www.mathworks.com/ntbm	527	17
MDC Vacuum Products Corporation	www.mdc-vacuum.com	431	88
Metrum-Datatape	www.metrum-datatape.com	412	32
Micron Electronics, Inc.	www.micronpc.com	542, 673	13, 15N
Microway	www.microway.com	505	73
Minco Products, Inc.		443, 691	104, 23N
MiTAC Industrial Corporation	www.mitacinds.com	441	101
Mouser Electronics		806	13a
Nanonics Corporation	www.nanonics.com/catalog/	440	101
National Instruments Corporation	www.natinst.com	500, 413	COV II, 38
Nook Industries, Inc.	www.nookind.com	411, 675	18, 23N
Northwestern Tools, Inc.		610	83
NuSil Technology		531, 684	23, 8N
Ocean Optics, Inc.	www.OceanOptics.com	414	48
Omega Engineering Inc.	www.omega.com	513-514, 804	1, 13a
Omega Engineering Inc.		600-608	82
Omega Shielding Products Inc.	www.omegashielding.com	451	110
Omnetics Connector Corporation		462	12a
Paroscientific, Inc.	www.paroscientific.com	444	105
Patriot Sensors & Controls	www.xducer.com	449	109
Penn Engineering & Manufacturing Corp.	www.pemnet.com	456, 687	11a, 6N
PolyScience	www.polyscience.com	434	92
Quality Expo '98			64C-D
Racal Instruments	www.racalinst.com	455	9a
Research Systems, Inc.	www.rsinc.com	515, 699	COV IV, 16N
RGB Spectrum	www.rgb.com	410, 676	12, 24N
Rolyn Optics Co.		581, 609	111, 83
Rubbercraft/Alloy Die Casting	www.alloydie.com	453	5a
SAIA-Burgess Electronics	www.SAIA-Burgess-USA.com	463, 464, 683	10a, 23N
Saltire Software Inc.	www.saltire.com	612	83
Sensor Products Inc.	www.sensorprod.com	432, 694	90, 23N
Servometer	www.servometer.com	447	108
Silicon Graphics, Inc.	www.sgi.com/go/workstations	572	19
SL Corporation	www.sl.com	502, 672	89, 17N
SolidWorks Corporation	www. solidworks.com/3041	550, 698	15, 4N
Sony Precision Technology America, Inc.	www.sonypt.co.jp	460	1a
Sorbothane Inc.	www.sorbothane.com	458	102
SpecTran Specialty Optics Company		544	87
Synrad, Inc.	www.synrad.com	557	59
TA MFG.		427	76
TAL Technologies, Inc.	www.taltech.com	616	83
Teknor Industrial Computer		677	24N
Tescom Corporation		439	100
TMG, the motion group		582	111
Trim-Lok Inc.		442	104
True Time Inc.	www.truetime.com	615	83
Velmex, Inc.	www.velmex.com	473, 474	102
Voltek		446	106
Wolfram Research, Inc.	www.wolfram.com/v3/ntb	552	85
Working Model Inc., Div. of Knowledge Revolution	www.workingmodel.com	680	9N
Xerox Engineering Systems	www.xerox.com/XES	536	10-11
The Zippertubing Co.	www.zippertubing.com	438	100
Zircar Products, Inc.	www.zircar.com	425	69

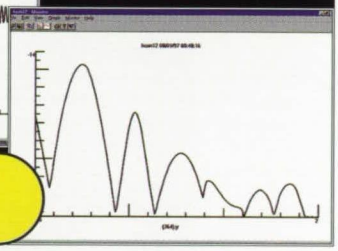
NASA Tech Briefs, ISSN 0145-319X, USPS 750-070, copyright ©1998 in U.S. is published monthly by Associated Business Publications Co., Ltd., 317 Madison Ave., New York, NY 10017-5391. The copyright information does not include the (U.S. rights to) individual tech briefs that are supplied by NASA. Editorial, sales, production, and circulation offices at 317 Madison Ave., New York, NY 10017-5391. Subscription for non-qualified subscribers in the U.S., Panama Canal Zone, and Puerto Rico, $75.00 for 1 year; $125 for 2 years; $200.00 for 3 years. Single copies $10.00. Foreign subscriptions one-year U.S. Funds $195.00. Remit by check, draft, postal, express orders or VISA, MasterCard, and American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017-5391. Periodicals postage paid at New York, NY and additional mailing offices.

POSTMASTER: Send address changes to *NASA Tech Briefs*, PO Box 10523, Riverton, NJ 08076-9023.

LINEAR STATIC FEA IS FINE IF YOU MAKE STONE STRUCTURES WHICH AREN'T GOING TO MOVE FOR THOUSANDS OF YEARS.



PYRAMID ENGINEERS DID NOT NEED TO PLOT SUCH THINGS AS ACCELERATION OR STRESS VS. TIME.



IN THE REAL MECHANICAL WORLD REAL THINGS EXPERIENCE DYNAMIC LOADS THROUGH IMPACT AND OTHER CHANGES IN MOTION AND ARE NEVER COMPLETELY RIGID. ACCUPAK/VE SIMULATES REAL EVENTS WITH FLEXIBLE BODY MOTION AND PREDICTS IF AND WHEN A PART WILL FAIL AND PRODUCES A COMPLETE ANALYSIS OF STRESS VS. TIME.

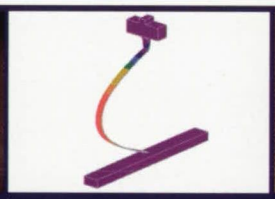
ACCUPAK/VE IS NOT LIMITED TO "RIGID BODY" MOTION.

FLEXIBLE BODY MOTION AND FEA IN ONE PROCESS!

BELOW, SCENES FROM A RECENT ALGOR VIDEO SHOW ACCUPAK/VE PREDICTING WHAT HAPPENS TO AN ALUMINUM BAR WHEN A WEIGHT IS PLACED ON ITS END. THE EVENT SIMULATION INCLUDES BUCKLING, THE COMPLETE POST-BUCKLING SCENARIO AND CONCLUDES WITH PERMANENT DEFORMATION.

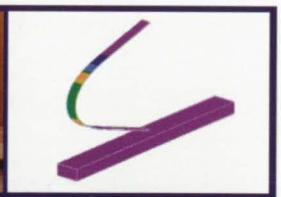
PRECISION MODELED WITH ALGOR'S SUPERDRAW III

EXPERIMENT SET UP IN LAB



SIMULATING THE EVENT WITH ACCUPAK/VE

POST-BUCKLING SCENARIO IN THE LAB



FINAL PERMANENT DEFORMATION SHOWN IN ACCUPAK/VE

Event simulation is the easy-to-use alternative to linear static and dynamic FEA.

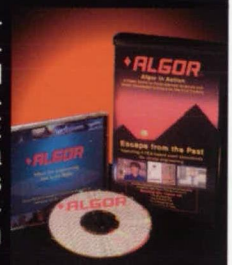
- Eliminates need to determine forces by external calculations or expensive experiments
- Handles motion combined with impact
- At linear prices
- Shows nonlinear effects such as material yielding or cracking if they occur
- Integrates fully with your CAD system

Cad systems supported:

AutoCAD	CADDS	MicroStation	EDS/Unigraphics	Solidworks
Cadkey	CATIA	MSC/Aries	SDRC	Xitron
CADMAX	Intergraph	Pro/ENGINEER	Solid Edge	

Get your free demo video and CD-ROM to see Algor software in action

Video includes 18 action-packed minutes of real-world examples combined with Algor FEA demonstrations. See Accupak/VE in action. CD includes a complete version of Algor's website with detailed information and software you can try.



Visit Algor at:
WWW.ALGOR.COM

Products

Service

Download Trial Software

You have 4 ways to get a free demo video and CD-ROM:

1) Call: +1 (412) 967-2700
2) WWW.ALGOR.COM
3) E-mail to: info@algor.com
4) Complete this form and fax to: +1 (412) 967-2781

Name _____ Company _____

Address _____

City _____ State/Prov. _____ Zip/Postal Code _____

Country _____ Telephone _____

Fax _____ E-mail _____ (ES1)

ALGOR®

When the Engineering Has to be Right

Algor, Inc.
150 Beta Drive, Pittsburgh, PA 15238-2932
USA
Phone: +1 (412) 967-2700
Fax: +1 (412) 967-2781
California: +1 (714) 564-0844
Europe (UK): +44 (1) (784) 442 246
E-mail: info@algor.com

For More Information Circle No. 506

Create Revolutionary Results. Fast.

IDL SOFTWARE

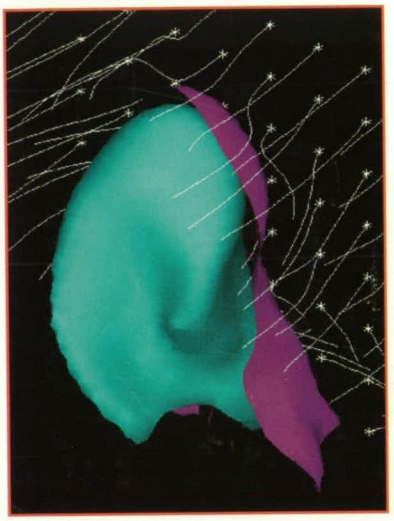


Image processed in IDL software and courtesy of NASA and ST ScI.

Visualize your data with IDL®, the *Interactive Data Language*, and see results in a whole new way.

Easily create amazing graphics with IDL software's accelerated 3D system. Want to spin or fly-through a surface? No problem. Shade and illuminate with multiple light sources?

IT'S A SNAP IN IDL.

IDL software's array-oriented architecture is designed for high-performance processing of large, complex data. That's why it's the standard in the world's preeminent medical, military, engineering & science organizations. IDL is so efficient that a few lines of IDL can do the job of hundreds of lines of C or Fortran. And, its object-oriented system lets you develop sophisticated applications from reusable code modules.

Analyze data faster. Create simulations easier. Write better applications.

Read in, analyze and output your data with the click of a mouse with IDL Insight™.

Connect to your relational database with the IDL DataMiner™.

Automatically share your programs – with full graphical interfaces – among Windows, Unix and Macintosh systems. Check out our flexible license options – we'll help you protect your intellectual property and economically distribute your applications.

Create maps in any of 16 projections.

Crunch numbers with IDL's integrated mathematics, statistics and industry-standard Numerical Recipes™ algorithms.

new release

IDL® 5.0

For More Information Circle No. 515

Stop waiting for your results. Call us for a free Demo CD or visit our website and download it today. www.rsinc.com

Research Systems 303-786-9900 info@rsinc.com Software ≡ Vision™

International Distributor Offices

Austria, Germany, Liechtenstein, Luxembourg, Switzerland, The Netherlands CREASO. GmbH tel: 49 8105 25055 • **Brazil** SulSoft tel: 55 51 337 38 91 • **China, Hong Kong** 3-Link Systems Pte Ltd. tel: 86106 261 0161
France, Belgium Fast Parallel Solutions France tel: 33 1 41 73 20 00 • **Italy** Alliant Computer Systems SRL tel: 39 39 6091766 • **Japan** Adam Net Ltd. tel: 81 35802 2251 • **Korea** InterSys tel: 82 42 869 4746
Spain Estudio Atlas tel: 34 45 298 080 • **Taiwan** Concentrate Corporation tel: 886 2 883 7752 • **United Kingdom** Floating Point Systems UK Ltd. tel: 44 118 977 6333